A SPECIAL REPORT

Get the Most From Instrumentation

☑ Check list helps you get better application and proposes standards for installing instruments p. 89

OIL, GAS AND PETROCHEMICAL PROCESSING

Petroleum Refiner

DECEMBER
1959

MOBIL FINDS
Key to Propylene Alkylation 101

EXPERT PANEL
How to Cut Maintenance Costs 133

For a "Quick Look" at this issue, turn the page . . .

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Volume 38, No. 12 December 1959

SPECIAL REPORT ON INSTRUMENTATION

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PETROLEUM REFINER, published on the 12th day of each month. Second class postage paid at Houston, Texas.

Petroleum Refiner

OIL, GAS AND PETROCHEMICAL PROCESSING

A Gulf Publishing Company Publication

A Quick Look at This Issue

These handy digests permit checking ☑ the articles you want to read first.

SPECIAL REPORT ON INSTRUMENTATION

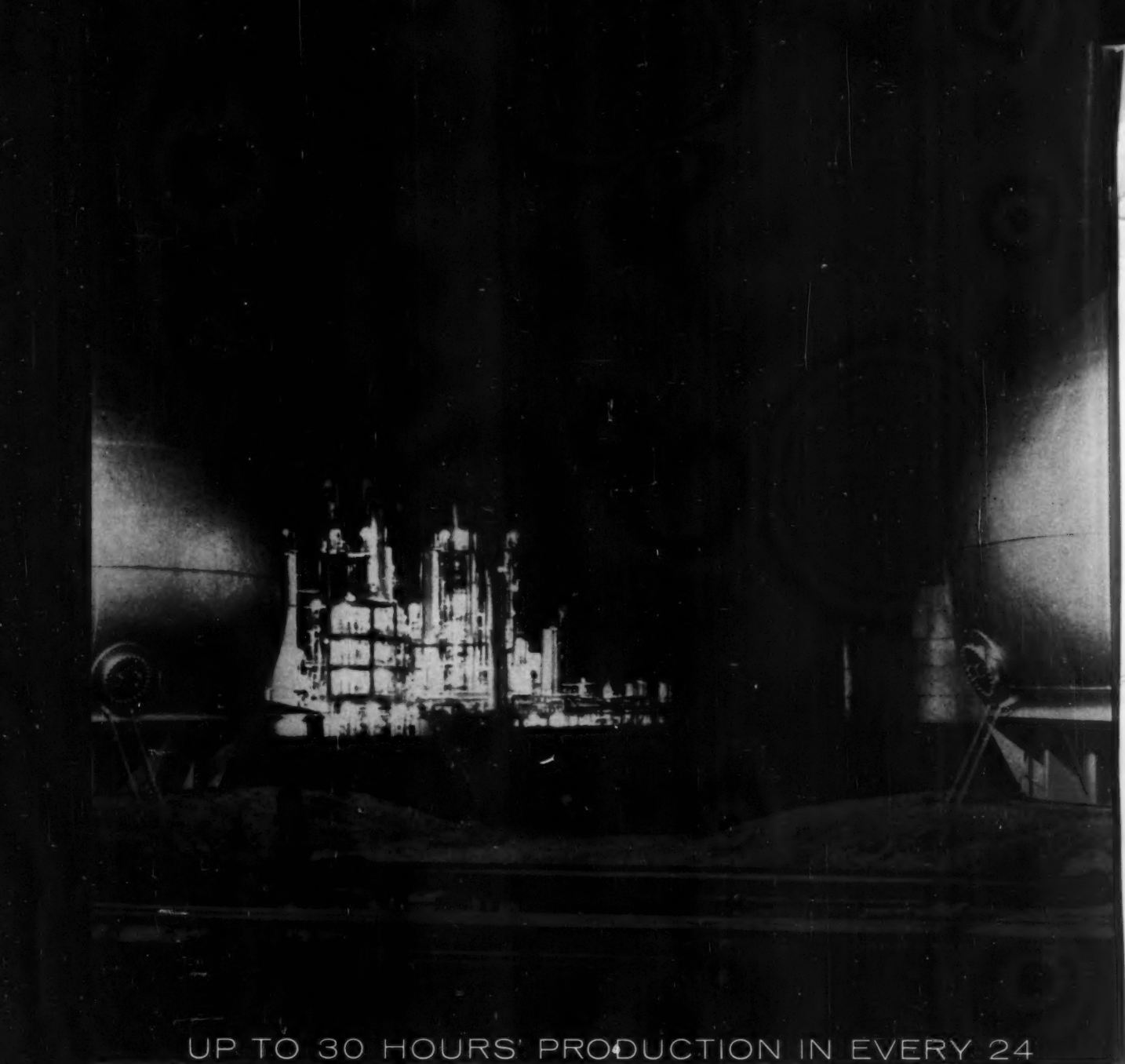
☐ **Get the Most from Instrumentation . . .** Here's a check list for better instrument application. Not only does it give standards for installation of instruments but for all associated equipment as well. Designed as a model agreement between refiner and engineer-constructor, the check list also will help you decide on day-to-day instrument usage. Be sure to turn to **Page 89.**

☐ **Key to Propylene Alkylation Found . . .** Here's the story on how Mobil Oil uses propylene without getting high acid consumption. The secret is oil-acid dispersion in the reactors. Be sure to read this informative article which starts on **Page 101.**

☐ **Automation Today (Part 16) . . .** Here you'll learn how the Nyquist diagram can represent the frequency response of a system with one line rather than the two needed for a Bode diagram. This interesting and informative discussion shows how an inverse Nyquist diagram sometimes can be easier and simplier to make. Be sure to keep up with the language of automatic control by following this stimulating series. Turn now to **Page 105.**

☐ **New Design Cuts Pump Cost 20 Percent . . .** Shell Chemical's study of 650 process pumps showed a need for simplified installations and maximum interchangeability. The result: a new design vertical centrifugal pump. Only one size meets 80 percent of the plant's requirements. For complete details on this new development, turn to **Page 109.**

Please Turn Page ➜



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A Quick Look at This Issue . . .

☐ **How and Why Butyl Moved to Europe . . .** tells an interesting factual story of France's need for synthetic rubber. For complete details and the construction story, turn to **Page 113.**

☐ **Thermo Data for Petrochemicals (Part XXV) . . .** This part covers the data for chlorofluoromethanes. These data are all wrapped up in a neat bundle for you so you'll have this information for future reference. You'll find it on **Page 117.**

☐ **Add Eye Appeal to Structural Design . . .** Conventional process unit structures are usually designed with cumbersome columns and heavy beams. But here is a flat plate exchanger structure supported on monolithic columns that combines appearance with good engineering. For full details on how it was built, turn now to **Page 121.**

☐ **Applied Hydrocarbon Thermodynamics (Part 15a) . . . Flash Vaporization Conditions and TBP Curves of Equilibrium Vapor and Liquid from Terminal Volatilities . . .** If the TBP curve approaches a straight line, great simplifications can be made in developing analytical solutions. See for yourself—turn to **Page 125.**

☐ **Tips on Maintenance From Panel Talks . . .** From notes taken at a panel discussion on plant maintenance problems at the ASME Petroleum Engineering Conference, Houston, Sept. 21, 1959, you can learn new trends in the industry. They talked about shift work, area maintenance, and industrial engineering techniques that cut maintenance costs 10 percent in 1958. You'll find how to cut costs in your own plant by turning to **Page 133.**

☐ **Predict Octanes for Gasoline Blends . . .** The final octane rating of a gasoline blend can be influenced greatly by the olefin concentration of the components. Here is a way to estimate what the blend octane will be. This method accounts for the non-linear effects which keep popping-up in blending operations. For the full story, turn to **Page 135.**

☐ **How to Get Along in Latin America . . .** With the increasing significance Latin America is playing in the world today, it is becoming more and more important for you and your organization to strive for good public relations south of the border. Here are a few tips which will enable you to interpret Latin America with a Latin American view. Turn to **Page 177.**

☐ **The Violent Nature of Detonations . . .** During the past several years, major hydrocarbon detonations have become more and more frequent. Therefore, you'll want to read this up-to-date information which explains the differences between "normal" explosions and detonations—and how to avoid both. Turn now to **Page 179.**

☐ **Try This Approach to Plant Problems . . .** During your career as an engineer, you will constantly be faced with different types of problems. Therefore, you'll want to read this article which offers some valuable pointers on how to go about solving some of these problems. You'll find this reading both informative and enjoyable, so turn now to **Page 185.**

Your Annual Index

PETROLEUM REFINER has followed the practice for some years of including in its December issue the Annual Editorial Index covering the 12 issues for that year.

The 1959 index appears in this issue as an insert opposite Page 140. It is called to your attention so that you might take whatever steps your situation calls for in preserving it for future reference.

A number of improvements in indexing procedure have been effected in this 1959 compilation, all designed for reader convenience. If you find that other changes toward this end are needed and will memo the editor, they will be considered for the 1960 Index. Separates of the 1959 Index may be had by addressing Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas. These extra copies, where needed, are furnished free to subscribers.

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the one complete line for corrosive locations

Photo shows Feraloy Condulet conduit fitting after several years exposure to hydrochloric acid. Note extreme deterioration of conduit.

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RESISTS varying concentrations and temperatures of corrosive liquids, vapors, gases, dusts

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PETROLEUM REFINER
Is Published By
GULF PUBLISHING COMPANY

EXECUTIVE OFFICES: 3301 BUFFALO DRIVE, HOUSTON

Cable Address, Gulfpubco, Houston

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Advertising rates on application.

SUBSCRIPTIONS

R. B. Reilly, Circulation Manager, P. O. Box 2608, Houston 1, Texas U.S.A. Single copies 50 cents (except special issues) for domestic and foreign. Double price for copies over one year old. Subscription rates—both foreign and domestic $2 a year. Subscriptions restricted to those engaged in oil, gas and petrochemical processing industries or service and supply company personnel connected thereto. Copyright 1959 by Gulf Publishing Company.

Postmaster: Send notification (Form 3579) regarding undeliverable magazine to Petroleum Refiner, Box 2608, Houston 1, Texas.

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PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.

Petroleum Refiner is indexed by Industrial Arts Index, Chemical Abstracts and by Engineering Index, Inc. Microfilm copies available through University Microfilms, Ann Arbor, Michigan.

Now Another Handbook

A NEW LOOK for PR's maintenance readers will be coming up in January when they receive the first Maintenance Handbook for refineries, petrochemical and natural gasoline plants ever compiled.

Because maintenance is one plant operation that is done just a little differently in each and every plant, maintenance authors have been reluctant to claim that theirs "is the best way to plan and schedule and the industry should adopt our methods." No, they may brag a little about the way it's done in their plants but it usually ends there. Certainly there has never been an effort to sort out these methods and compile a handbook specifically for this work phase of the industry.

Now PR's Maintenance and Design Editor has done just that. He has been reviewing all the literature for the past six years and by putting it together a modern roundup on maintenance practices will be ready for the Maintenance Special Report in PR's January issue.

Where'd the Man Go?

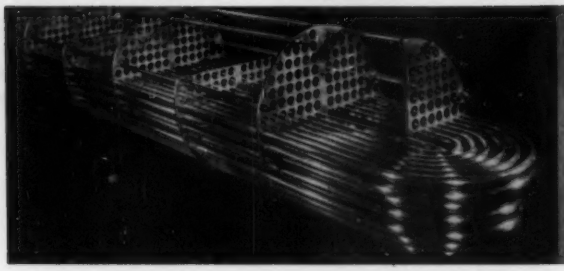
HAVING RECEIVED so many reader comments, we assume a lot of you want to see more on "Automation Today"—the series designed to acquaint you with some of the basic concepts of automatic control. And more you will see. Publication of this interesting series was resumed in October. So now you can continue your up-to-date review of the techniques in modern process control analysis. The author, Dr. Theodore J. Williams, is an expert in the use of analog computers. And automatic control is one of those subjects that lends itself well to handling by this kind of computer. In fact—too well.

From time to time special computer problems have demanded so much of Dr. Williams' attention he was forced to discontinue the series in the PETROLEUM REFINER. But now he has teamed up with an associate, Verlin A. Lauher, in order to get the series underway again. Be sure to keep up with "Automation Today." Part 16 starts on Page 105.

It's A Textbook

OUR "As Management Sees It" Editor, Clay Umbach, attended the annual meeting of the National Safety Council in Chicago in October and there saw Joe Risinger, author of the "Safety and Fire Protection" series that appeared in PR's columns two years ago. This was and is a most valuable treatment of a subject that is hot in more ways than one. Reprints were available at the NSC meeting and safety supervisors were taking them in quantities for company distribution. One such official, connected with a large integrated company expressed the thought that "this reprint will become a textbook on safety and fire protection in the industry."

This "textbook," in event you didn't save tearsheets when the articles appeared, may be had at $1.00 per copy by addressing Reprint Department, PETROLEUM REFINER, Box 2608, Houston 1, Texas. It contains 48 pages of most valuable information.



CONDENSER AND HEAT EXCHANGER CLINIC

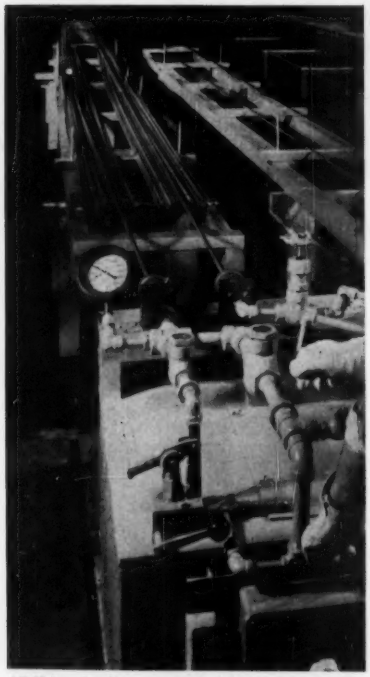
Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New controls and services meet increasingly critical requirements in heat-transfer units

As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100′—can be inspected electronically by eddy-current equipment.



All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.

All tubes are inspected visually one at a time, both externally and internally.

When required, tubes are inspected by eddy-current equipment, located at the tube straightener.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASTM Specification pressures. They can, however, be tested at ASME Code pressures, up to 6000 psi, on request, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5958 Rev.

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Quick Look at Industry...

Air Pollution Blamed on Olefins . . .

Air pollution experts seem sure now formaldehyde and acrolein causing eye irritants in West Coast smog. Both formed from sunlight on olefinic hydrocarbons in atmosphere. And note this: 95% of olefins in the air stems from auto exhausts.

Notes on Oil Glut . . .

Conoco President McCollum claims U.S. oil oversupply has been increasing since World War II. Reserve ratio to annual production climbed from 20 to 1, to 43 to 1——predicts it will last another 5 years.

Shell Oil President Burns says excess refinery runs having greater effect on current oversupply than imports, but overcapacity being corrected by absence of refinery building—present refinery overcapacity should be corrected by '65.

Americans Hard on Tires . . .

American motorists wearing out about 400 million pounds of tire rubber yearly through abrasion. Cost: about $2½ billion to replace or recap. But in spite of continually improving tire compounds and designs, abrasion continues as mounting problem. Major causes: higher speeds, fast corners, rapid braking and acceleration.

Industry Fires Down—Oil Fires Up . . .

All industry made progress last year in reducing property losses from fires according to National Fire Protection Association. Fire damage and destruction in plants of all types in '58 down by nearly 25%. But losses still totaled more than $175 million.

By contrast, fire losses rose sharply in petroleum facilities. Damage to refining and bulk storage plants cost more than $16.5 million in '58 as compared with $11.3 million year before.

Caltex Turkey Plant Gets Green Light . . .

Caltex and Turkish Petroleum (TPAO) sign agreement to build 20,000-bpd refinery near Izmit in Istanbul area. Cost: about $26 million. Ownership gives 51% to Turkish Petroleum and 49% to Caltex with Caltex operating for 10 years. Both may draw up to 10% a year of the capital from annual profits, with remainder to be divided 90% for TPAO and 10% to Caltex. On stream date: Jan. 12, 1962.

Panning the Building Scene . . .

Ashland O&R to build hydrodealkylation unit to produce synthetic benzene and naphthalene at Frontier Oil refinery, Tonawanda, N. Y. . . . Bitumen and Oil Refineries (Australia) plans $4 million cat cracker at Matraville plant . . . Signal Oil starts engineering studies for "extensive" expansion of recently acquired Eastern States Petroleum and Chemical plant, Houston . . . Standard Vacuum submits proposal to Malay government for refinery and fertilizer plant construction.

Russians Hiking Oil Goals . . .

Russian state planners now switching fuels emphasis from coal to oil and natural gas. In the past, Russian energy requirements came 60-70% from coal and 20-25% from gas and oil. Present 7-year plan which runs to 1965 plans to hike petroleum to 50% while coal drops to 42%. If success-

ful, Russian oil production in '65 will hit 4.5 million bpd as opposed to today's 2.5 million bpd. One possible result: increased flow of Russian crude to Free World from present 200,000 bpd to 500,000 bpd in '65.

Panning the Labor Scene . . .

After 134 days on strike, workers at Amoco's El Dorado, Ark., refinery back on the job—new contract says management can require employes temporarily to do jobs of another classification. Tired of the stalemate, members of Local 8-434 ignored professional OCAW negotiators, and voted to accept latest management offer. Proves locals don't always see eye-to-eye with international.

Seeing some action at Amoco's Texas City plant too as 14 employes filed $370,000 suit against union for conspiracy to keep them from working. Union raged back with $10,000 damage suit against each of the 14 charging "malicious interference" in contractual relations between union and its members. Meanwhile, 18 workers crossed picket lines to return to work. On Dec. 10, strike hit 163rd day.

Quick Look Around the World . . .

Continental Carbon, Pakistan government, and Pakistan Petroleum organizing Sui Carbon, to build 17,000-Mcfd carbon black plant at Sui, West Pakistan. Cost: about $7 million . . . World oil production in '58 hit 6.618 billion barrels—up 3% over '57. Biggest increase in Russia where output rose 16%. . . Carbon black, now used for coloring in black jelly beans, must be proved safe or eliminated from foods . . . Interesting facts department: API estimates 8 more 3-day week-ends yearly would boost gasoline demand about 2%.

More Miles Per Gallon . . .

Auto experts predicting 83 million cars in use by 1970—with at least 20 million in the economy class capable of 25 miles a gallon. Some even saying all cars will be getting one-third more mileage by then.

Ammonia at Room Conditions . . .

At recent Texas U. seminar, Princeton's Professor Boudart used pure nitrogen and hydrogen plus special iron catalyst to produce ammonia at room conditions. Recommends, though, that industry not throw away present high pressure plants—reaction rates and concentrations way below those desired.

Synthetic Rubber to Fill World Needs . . .

With growing demand for more and more rubber, synthetic capacity may double within next 10 years. Natural will just about hold its own due to lack of planting higher-yield trees—also, takes 7 years before high-yield trees start producing.

Up, Up and Away . . .

Focusing on the octane picture: premium grade gasolines hit the 99.3 F-1 mark last month for an increase of 0.1—regular held steady to 92.9 F-1.

Quick Look at Cat Cracking . . .

More potential feedstock available now for cat crackers by digging deeper into heavy residuals. According to recent AIChE meet, closer looks being given to vacuum distillation, solvent extraction (with phenol, propane or furfural), hydrodesulfurization or delayed coking. These processes make more refinery stocks suitable for cat charge.

WHY BUELL CYCLONES ARE USED IN OVER 80% OF ALL CATALYST RECOVERY SYSTEMS IN THE U.S. AND CANADA

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Performance tests have demonstrated the effectiveness of FOA-2. For example, in one test with a heavy cycle stock treated with FOA-2, the engines ran for 35 days without changing filters and without appreciable pressure drop. Without FOA-2, the filters became blocked in one week.

FOA-2 not only cuts sludge formation, it often cleans parts where sludge has begun to build up.

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Because of its many outstanding advantages, Du Pont FOA-2 is now being widely and successfully used by many oil companies in the diesel fuels supplied to the nation's leading railroads.

Your Du Pont representative can fill you in with further details. Or you can write for more information to E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

Better filterability of FOA-2 treated fuel is shown here. The filter at the left was clogged in a week's use of untreated economy fuel. The clean filter at the right was used several weeks in an economy fuel with FOA-2 added.

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A Tarnished Bit of Gold

AS 1959 DRAWS TO A CLOSE, it is with some optimism, and perhaps even some trepidation that we look forward to the entry of the '60s. How swift the time has flown, for it hardly seems like 10 years since 1949 when we were looking forward to the '50s and wondering what untold fortunes and crises the years would bring. But of course we now know, so again, we pause for a moment to reflect on a new decade.

Of one thing we can be certain though—and that is the tremendous technological advances made during the past few years, coupled with the gradual easing of world tensions promise at least a half-bright outlook for what some have termed the "golden '60s." However, we who are in the oil industry can look forward to some tarnish on our share of that "gold." For the sad fact is, that sitting in Washington are a few radical and very noisy legislators who will use the new year as a starting gun for new attacks on oil.

Best Lubricant. Sometimes it's difficult to understand just what these honorable Congressmen hope to accomplish. The only thought that comes to mind is that perhaps they have decided that oil is probably the best lubricant to speed them along the perilous road to political glory. As a result, therefore, we can look forward to the same accusations—the same trite platitudes and phrases striking out against whichever phase of oil is under fire.

For instance, take the issue of percentage depletion. The common tale woven around percentage depletion is that it is nothing more than a great big hole through which oil companies adroitly leap to avoid paying their fair share of taxes. Senator Proxmire (D-Wis.) calls it, ". . . the most notorious, the most indefensible loophole which our tax laws now permit."

The honorable Democrat from Oregon, Senator Wayne Morse, says, "In my judgment, the depletion allowance which the oil companies of the country have unjustly enjoyed for the past many years can be described as a pickpocket's knife which the oil interests have used for many years to slit the pockets of the American taxpayers."

The man who comes closest to the truth, however, is Senator Carroll (D-Colo.) who states, ". . . we do not know whether we are going to win this fight, but we have got to continue to make a record so people will become aroused on this issue."

And alas, in those few words the honorable Senator from Colorado touched at the very heart of this battle. For even if they cannot win on the senate floor, these Congressmen and a few of their associates are out to capture that sometimes strange and quite often fickle thing called public opinion. They have come to realize one of the basic fundamentals of human nature—namely that people are more apt to remember the sensational than the virtuous; the unusual and bizarre than the important.

Recalling Godiva. A. C. Rubel, President of Union Oil Company of California made this point quite effectively not long ago when he said that in Medieval England, there must have been scores, if not hundreds of well-born ladies who, at one time or another, interceded with their lords and husbands on behalf of the common people. Yet of all these scores and hundreds of Medieval women who crusaded for lower taxes for the tenants, and better working conditions for the serfs, the only one who is remembered today is Lady Godiva. And there probably aren't more than 5 percent of those reading this editorial who even know why she made her famous ride.

In our own situation, it is so much easier for the people to combine percentage depletion and oil companies in the same thought than it is to take into consideration that other industries—coal, iron, tin, zinc, uranium, asphalt, asbestos, granite, marble, talc, sand, gravel, clay, timber, and even deposits of clam and oyster shells—also receive percentage depletion.

And, isn't it easier for them to remember that oil interests have a "tax loophole" to leap through than it is to recall that in 1957 the tax burden to the petroleum industry amounted to $6.7 billion—not including the personal income taxes of all its employees.

But let's take another situation. In Houston an oilman by the name of Hugh Roy Cullen amassed a huge personal fortune, strictly by his own efforts. During his lifetime, Mr. Cullen gave away to schools and hospitals the staggering sum of $180 million.

By contrast, a few years ago an "oil millionaire" gave a two-day New Year's Eve party at Mike

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Romanoff's Restaurant in Beverly Hills which was supposed to cost about $50,000 or $60,000. This "oil industry activity" was attended by quite a few movie stars and thus, rated prominent headlines in the papers, plus a four or five page story in *Life*.

Mr. Cullen or the party—which did the most good? But which will people remember the longest?

As you can see, therefore, it's going to be up to each of us to keep our friends and neighbors informed of the true facts of oil. For, whether one thinks so or not, many of the critics of the oil industry are good people, but are actually ignorant of its operations. This is quite evident in the classic remark of a former director of the Office of Price Administration (OPA) who claimed, "It is an impoverished science that permits an industry to continue to drill dry holes. The wells that are going to be dry should not be drilled!"

It would do well for each of us to read and remember the words of President Theodore Roosevelt who contended, "It is the doer of deeds who counts in the battle of life, not he who looks on and says how the fight ought to be fought, without himself sharing in the struggle and the danger."

Now is the time to make your choice. Which will you—who are a part of the oil industry—be in the '60s—a doer or a looker?

The Good Ole Days?

ESSO'S BAYWAY refinery celebrated its 50 year anniversary in September. Built in 1909, this refinery was the East's largest at the time. To celebrate, Esso put on a fair that recalled people and things—the plant steam whistle, 74 original employes, and a 1922 Crawford car, to name just a few.

A 50-year-old paybook recording the wages paid to Bayway employes in the 1909 era was one of the most interesting historic exhibits at the fair. The pages are brittle with age, but the old-fashioned pen-and-ink entries are clear—so clear that they indicate the starting rate on some jobs was 11 cents an hour!

A loaf of bread then cost five cents, a six-room flat rented for about $15 a month, a suit of clothes cost the same and a pail of beer set you back eight cents.

So you think things were cheap in those days? Not in terms of earnings when you consider that the pail of beer ran to more than two-thirds of your hourly wage. And would you want to pay for two loaves of bread today the amount of money you earn in an hour?

The jobs that people did in the offices and in the refinery were more laborious and disagreeable in those days.

The paybook shows that a stillman on the crude stills average nearly 13 hours a day over a 13-day period.

But still we like to call them the "good ole days."

The Question: What's First?

SOME STORIES require an explanation before you read them—some call for an interpretation at the end. Yet others are so crystal clear in their import, they require neither. We feel this story as told by Charles E. Wilson, one-time president of General Motors, falls in that last category. See if you don't agree.

"Toward the end of World War II, I received word that six Swedes from Stockholm were going to visit me in Detroit. At that time I knew they could also get to Berlin, and I was careful to have our State Department clear them before our meeting in Detroit. Actually, they realized the war would soon be over, that Germany was about to collapse, and they were really doing a little postwar planning.

"I happened to mention to them that Americans did have some dual personalities and it might be a little difficult for some people to understand. They said, 'Yes, we understand—that's why America makes such great progress and that's why we're here.'

"In our conversation we, of course, discussed wages and prices and the inflation that had resulted from the war, and I asked them what their policy had been in Sweden. They said they had an agreement with all their labor unions that wages would go up half as fast as the increase in the cost of living. They pointed out Sweden could not hope to improve the standard of living of the people while they had the great extra cost of maintaining neutrality during the war. I said I understood perfectly, but how did they get the leaders of labor to reach such an agreement?

"Their answer was that because they were Swedes first and Unionists second."

Life Is Worth Living

IF YOU NEED some fresh data to feed your neighbor about how the oil industry has progressed in freedom, memorize these notes from a recent speech:

The average industrial worker today can buy enough gasoline with an hour's pay to drive a Valiant 224 miles. In 1924 the average worker could drive a Chrysler six 55 miles on the amount of gasoline he could buy with an hour's pay.

While the 1924 Chrysler six was priced at $1395, compared with the Valiant's price tag of $1874, in terms of constant dollars the Valiant is priced $500 lower than the first Chrysler, since the 1959 dollar is worth about 58 cents as compared with the 1924 dollar.

The average industrial worker in 1924 had to work more than a year to buy a 1924 Chrysler—three times as long as it would take today's worker to buy a Valiant.

Customer fuels are prepared for road rating in Ethyl's controlled-weather chassis dynamometer room.

Ethyl Research evaluates current premium fuels

Makes Results Available to Industry

ONE hundred thirty-one motor gasolines—112 premium and 19 super premium fuels—have been thoroughly tested in the laboratory and on the road in Ethyl's latest study of premium fuel performance.

Results of the study—including road performance evaluations for both full throttle and part throttle operation—are available to refiners as an aid to understanding current fuel problems and planning future fuels. In addition, Ethyl Research has expanded and brought up to date its system for calculating road performance from routine laboratory data.

All tests were conducted at Ethyl's Detroit Research Laboratories. Road tests were made in five 1959 cars and three test cars equipped with experimental high compression engines.

Of special interest is the information on part throttle operation since some late model cars are knock-limited at part throttle.

Summary of Ethyl Research Findings

1. Laboratory octane numbers may be used to provide estimates of road antiknock performance in 1959 cars. Whether Research or Motor octane number is more important varies with the car, engine speed and throttle setting.

2. A fuel property such as hydrocarbon composition and either Research or Motor octane also is a good index of road performance.

3. Low speed road performance in 1959 cars at full throttle operation depends primarily on Research octane number. For high speed, Motor octane is more important.

4. Experimental high compression cars were more ap-

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preciative of Research octane number than the 1959 cars.

5. Part throttle road behavior is controlled almost entirely by Motor octane. An increase of sensitivity is generally detrimental.

6. Where Research octane is the same, fuels with maximum paraffin hydrocarbons give optimum road performance.

7. Where Research octane and sensitivity are the same, fuels with more aromatics and less olefins show better road performance at high speeds.

Scope of the Test Program

Fuels tested in this study were obtained from 114 refineries representing 77 percent of the motor gasoline produced in the United States and Canada.

More than 3,500 separate laboratory tests were made, including 1,820 CFR engine tests. And more than 16,000 road ratings were made—14,200 at full throttle and 2,000 at part throttle—with the fuel samples blended to a TEL concentration of 3.0 ml per gallon.

The empirical correlation between road antiknock behavior and the laboratory characteristics of current premium gasolines was exhaustively re-examined to provide an accurate, up-to-date means for study of current fuel performance in today's cars.

Work with experimental high compression engines produced data which will be of great help in predicting future fuel performance and requirements.

AVERAGE COEFFICIENTS IN EQUATION RELATING ROAD OCTANE NUMBER TO LABORATORY VARIABLES

$$\text{Road ON} = a + b\,(\text{Research ON}) + c\,(\text{Motor ON}) + d\,(\%\ \text{Olefins})$$

FULL THROTTLE

FIVE 1959 CAR AVERAGE	A	B	C	D
Modified Uniontown	28.90	0.419	0.325	−0.038
Modified Borderline				
2000 rpm	11.48	0.644	0.273	−0.027
2500 rpm	26.84	0.408	0.359	−0.054
3000 rpm	27.50	0.371	0.386	−0.083
3500 rpm	21.99	0.313	0.502	−0.107

How Ethyl Research can help you

Since 1946, Ethyl Research Laboratories in Detroit have studied laboratory and road performance of premium grade gasolines at periodic intervals. This recent program is the largest undertaken.

For oil company statistical groups that wish to make further computer analysis of the data, Ethyl Research will supply a deck of IBM cards containing all available fuel variables and all road ratings for fuels at full throttle. Cards also are available for part throttle ratings for 28 car-speed combinations on 30 fuels.

Copies of the report compiled on this program entitled, "1959 Premium Gasoline Antiknock Behavior," may be obtained from your Ethyl Representative. He will gladly arrange for a presentation by an Ethyl Refinery Technologist.

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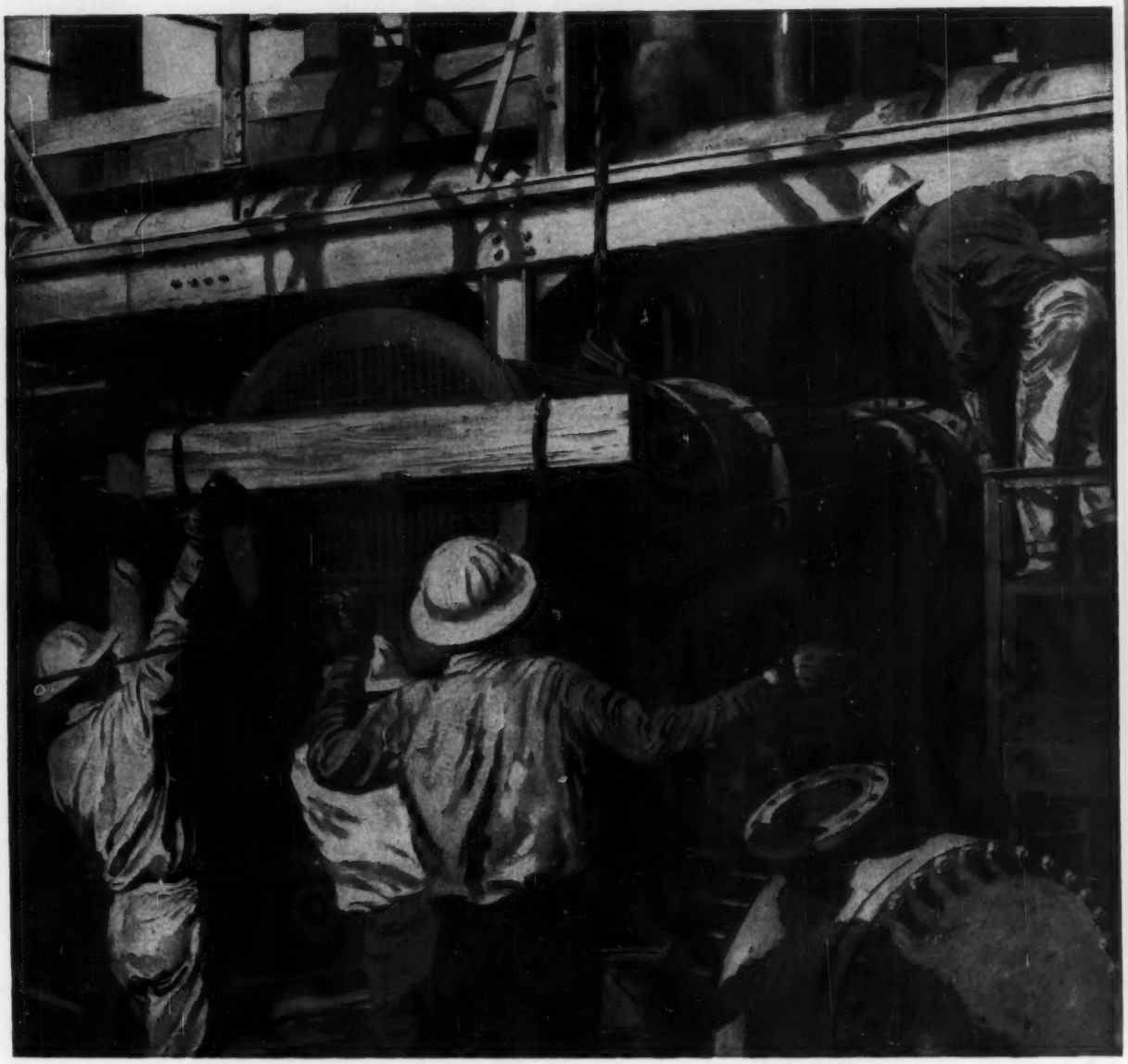

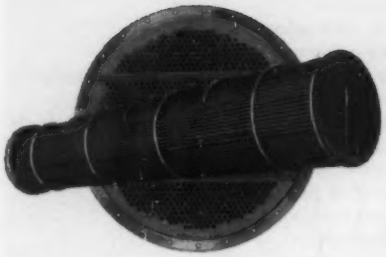

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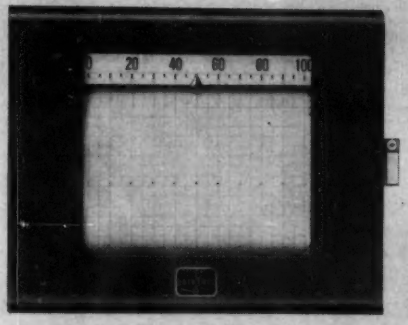

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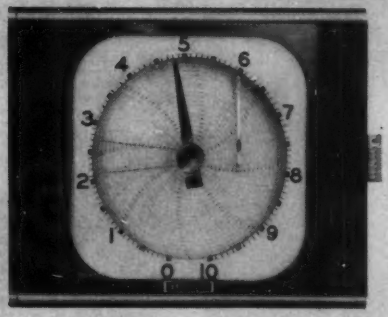

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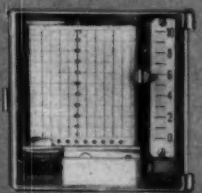

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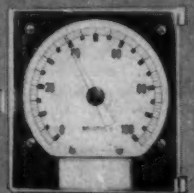

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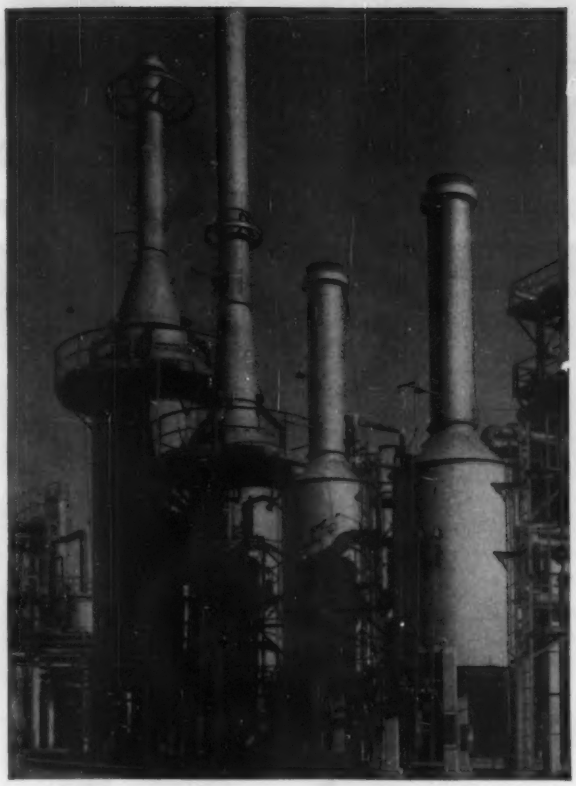

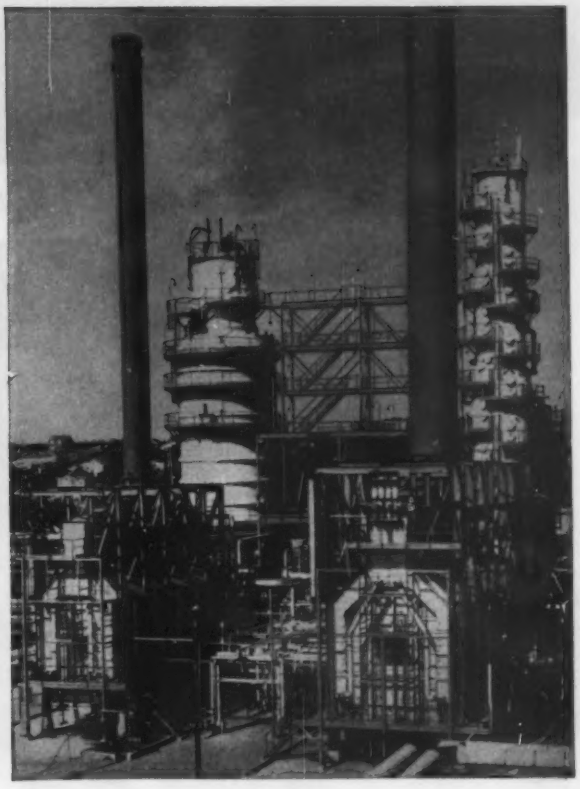

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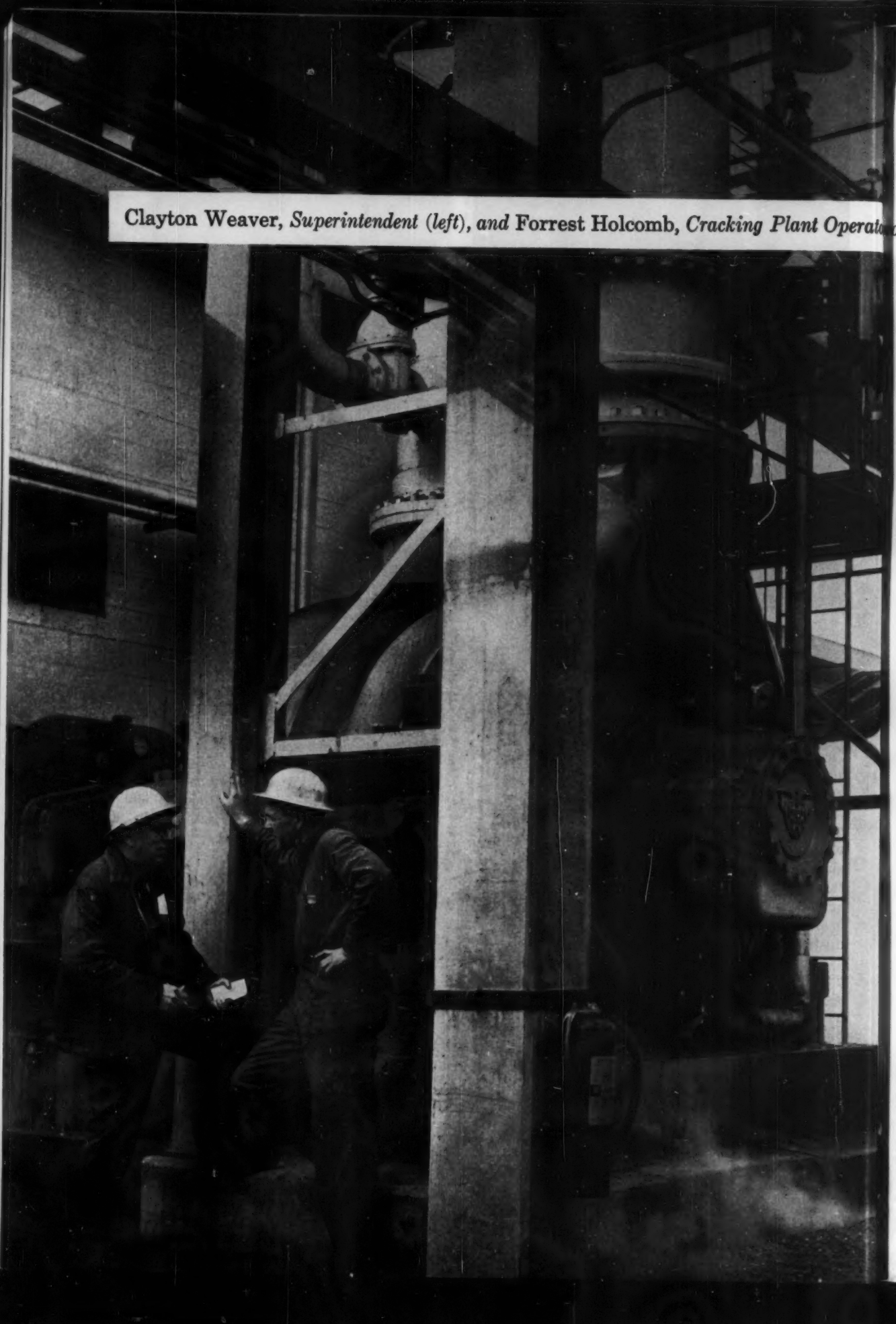

Clayton Weaver, *Superintendent (left), and* Forrest Holcomb, *Cracking Plant Operat*[illegible]*nard*

perat onard Refineries, discuss function of air supply in catalytic cracking and...

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As "Doc" Weaver, Superintendent of Leonard Refineries, Inc., Alma, Michigan explains . . . "Big centrifugals are the answer, of course, where modern processing calls for an extremely dependable air or gas supply at high volume and relatively low pressure. For example, our catalytic cracking requires this kind of air supply for burning coke off the catalyst. Our Cooper-Bessemer Type RS Centrifugal Compressor delivers 31,500 cfm at 30 psi discharge pressure. And, it produces this flow on a continuous, 24-hour basis. We are mighty pleased with its reliable performance."

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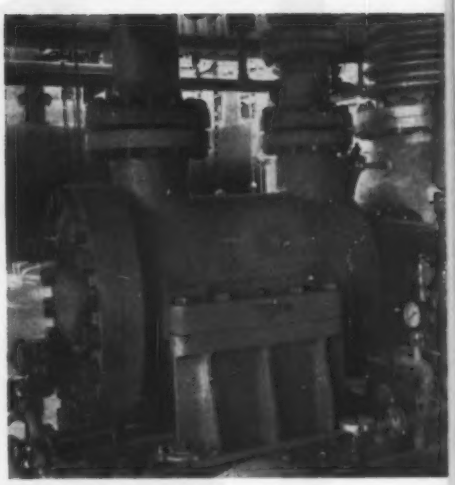

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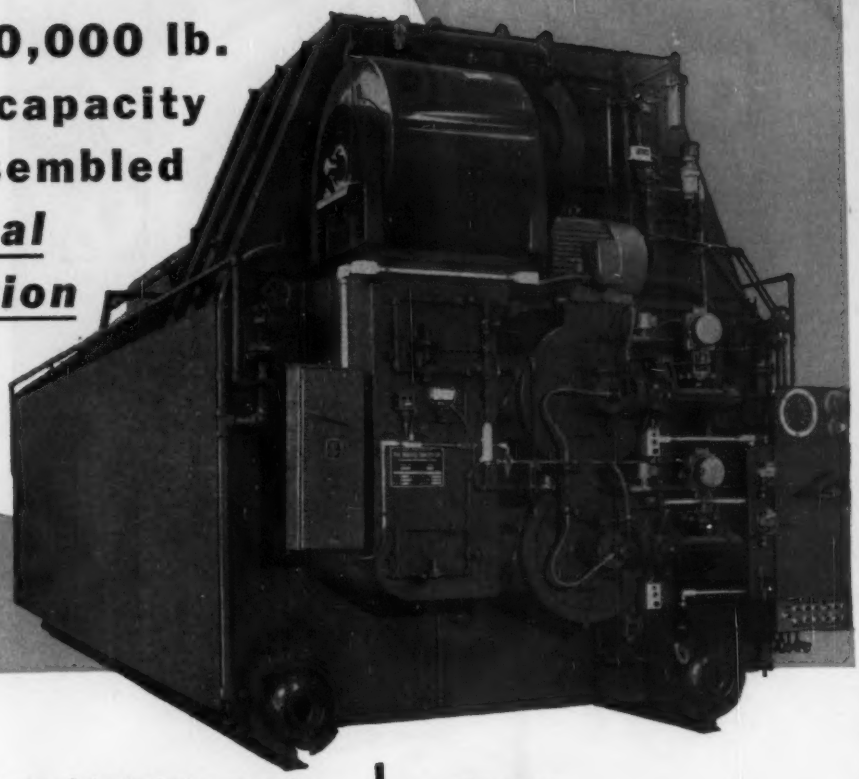

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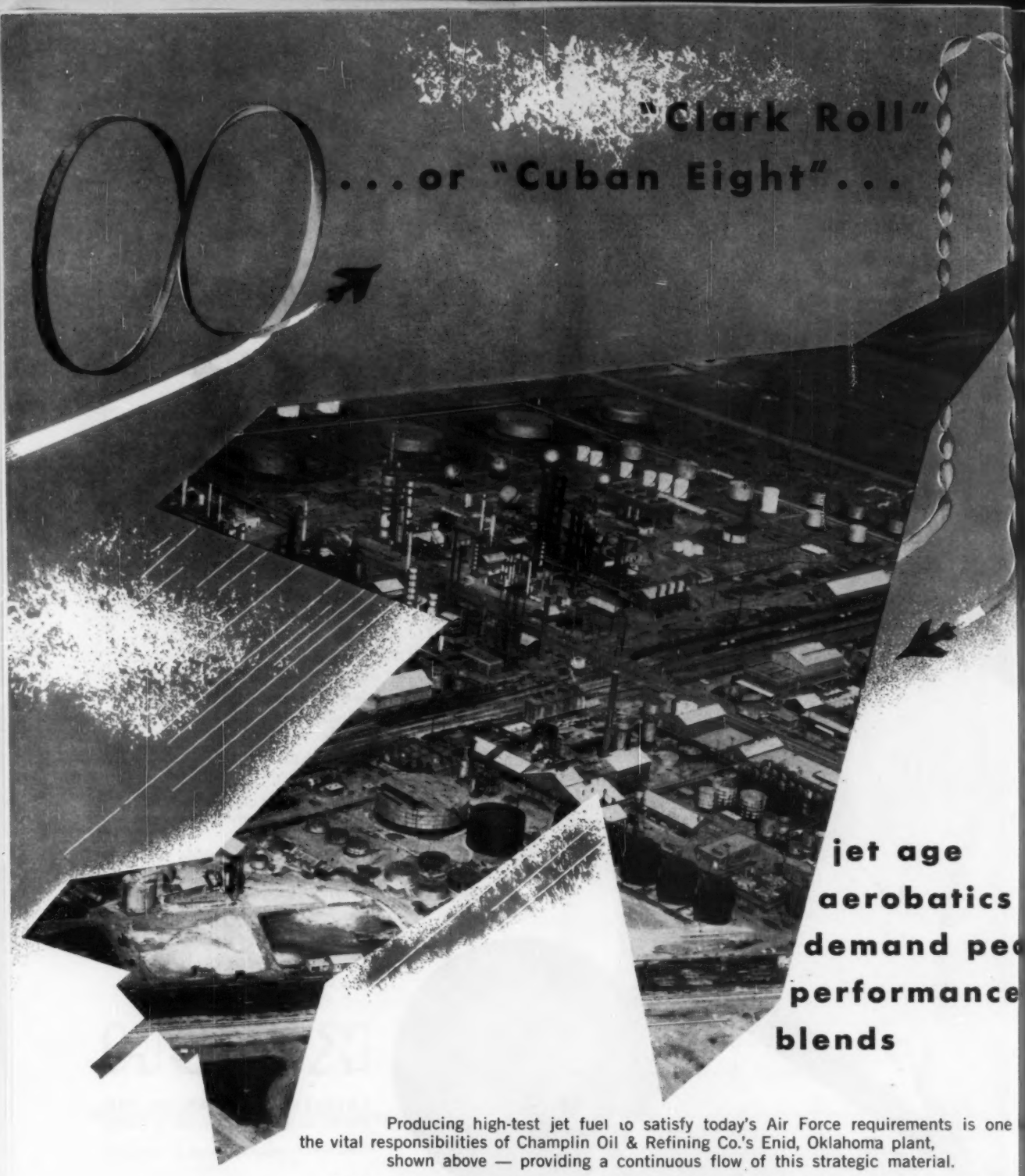
PARK RIDGE, ILLINOIS — M. B. Fisher, 1521 Courtland Ave.
PASADENA, CALIFORNIA — Engineered Process Equip. Co., 774 East Green St.
PITTSBURGH 19, PENNSYLVANIA — D. D. Foster Company, 2210 Koppers Bldg.
SALT LAKE CITY, UTAH — G. M. Wallace & Co., Continental Bank Bldg.
SOUTH CHARLESTON, WEST VIRGINIA — D. D. Foster Co., 411 "D" St.
ST. LOUIS 17, MISSOURI — Sample Brothers, 2010 Big Bend Blvd.
TULSA 16, OKLAHOMA — Myers-Aubrey Co., P. O. Box 5436
MONTREAL, CANADA — Robert Muddiman Co., Ltd., 739 Mountain Street
TORONTO, CANADA — Robert Muddiman Co., Ltd., 58 St. Claire Avenue E
LONDON, ENGLAND — L. M. Griffin, #6 Curzon Place, W-1
European Fabrication Available



Producing high-test jet fuel to satisfy today's Air Force requirements is one the vital responsibilities of Champlin Oil & Refining Co.'s Enid, Oklahoma plant, shown above — providing a continuous flow of this strategic material.

Another important function of the Enid plant is the production of high octane motor fu processed to the needs of modern high-compression engines for dependable "over-the-ground" power.

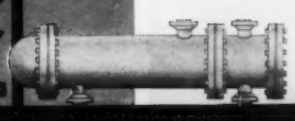
High-octane production at its Enid plant is centered in Champlin's HF alkylation unit, wherein Western Heat Exchangers are a ma factor in the production of the alkylate blending component used in the manufacture of this dependable fuel. The HF alkylati unit was designed and built by Badger Manufacturing Company.

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

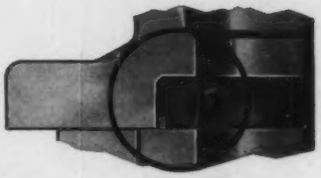
P.O. Box 1888 – Tulsa, Oklahoma



Western Heat Exchangers have become significant factor in all phases of the proc industry. A Western representative is wa ing to show you why.

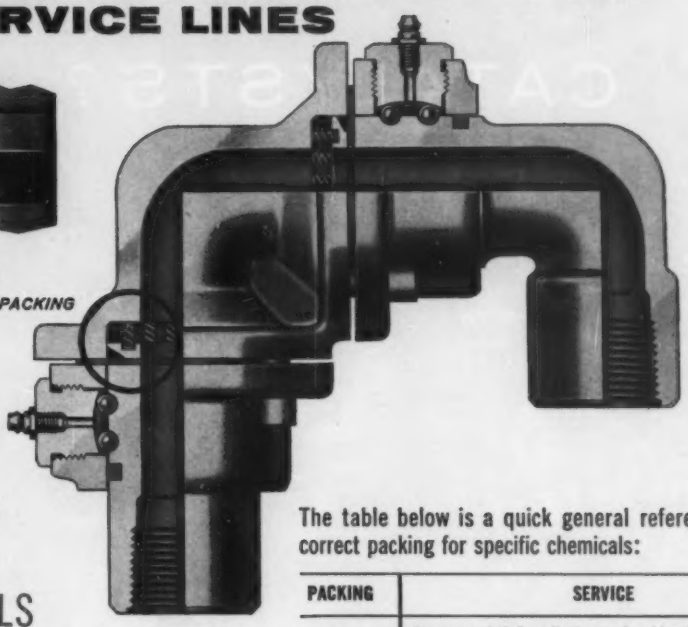
NEW CHIKSAN SWIVEL JOINT

GIVES SAFE, LASTING FLEXIBILITY TO CHEMICAL SERVICE LINES



VIEW ABOVE SHOWS MOLDED PACKING

VIEW AT RIGHT SHOWS DISC PACKING



INTERCHANGEABLE PACKING FEATURE ENABLES **DS SERIES** TO HANDLE A WIDE RANGE OF CHEMICALS IN SERVICES FROM –65°F TO +400°F AT 300 PSI

The table below is a quick general reference for the correct packing for specific chemicals:

PACKING	SERVICE
Neoprene	Recommended for alkaline and acid salt solutions and aldehydes such as formaldehyde.
Hycar	These should be used for petroleum derivatives, neutral or slightly acidic salt solutions, dilute acids (Sulfuric to 50%, Hydrochloric and Nitric to 20%), alcohols, glycols, ethers, gases (Oxygen not over 500 psi), and vegetable oils.
Butyl	Recommended for liquid or anhydrous ammonia, gases (except oxygen over 500 psi), ammonia derivatives such as hydrazine and for certain hydraulic fluids such as Pydraul, Skydrol, and Cellulube. It is recommended for acetone and methyl ethyl ketone.
Teflon*	Used for concentrated or fuming acids and other highly oxidizing fluids, esters, aromatics, liquid chlorine, bromine and fluorine if temperature is not excessive.
Asbestos	For use in saturated steam service.
Viton "A"*	Recommended for use with concentrated acids, aromatics, liquid chlorine, liquid bromine, chlorine or bromine derivatives, molten sulfur, and carbon disulfide.
Metallic	For extreme services such as hot gas at 600°F., a Stainless Steel metal disc, specially treated to prevent galling, is recommended.

* R.T.M. DU PONT

The DS Series swivel joint with its broad service range can be a valuable new tool in your process system. Use it in chemical loading of tank car or tank truck, for stress relief in piping subjected to vibration, expansion or settling, or as a steam rotation connection between stationary and revolving equipment. Wherever you use it, you'll find it pays for itself in extended service life.

Using a disc or molded type packing, this swivel joint can be applied to handle steam and any of a wide variety of chemicals processed in your plant. And the split segment feature of the DS Swivel Joint allows replacement of packings without removing the joint from the line.

Buy and apply Chiksan DS Series Swivel Joints for chemical service lines in your plant now. You can select from eight basic styles for full rotation in one, two or three planes. For more information write to Chiksan or fill in the coupon below.

CHIKSAN COMPANY, 330 North Pomona Ave., Brea, California

Please send me copy of Bulletin No. 1258

Name_____

Company_____ Title_____

Address_____

City_____ Zone____ State_____

#59-46

CHIKSAN fmc

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY—Brea, California • Chicago 5, Ill. • Newark 2, N.J. • Weco (Division), Houston 24, Texas • Subsidiaries: Chiksan Export Co. • Chiksan of Canada Ltd.

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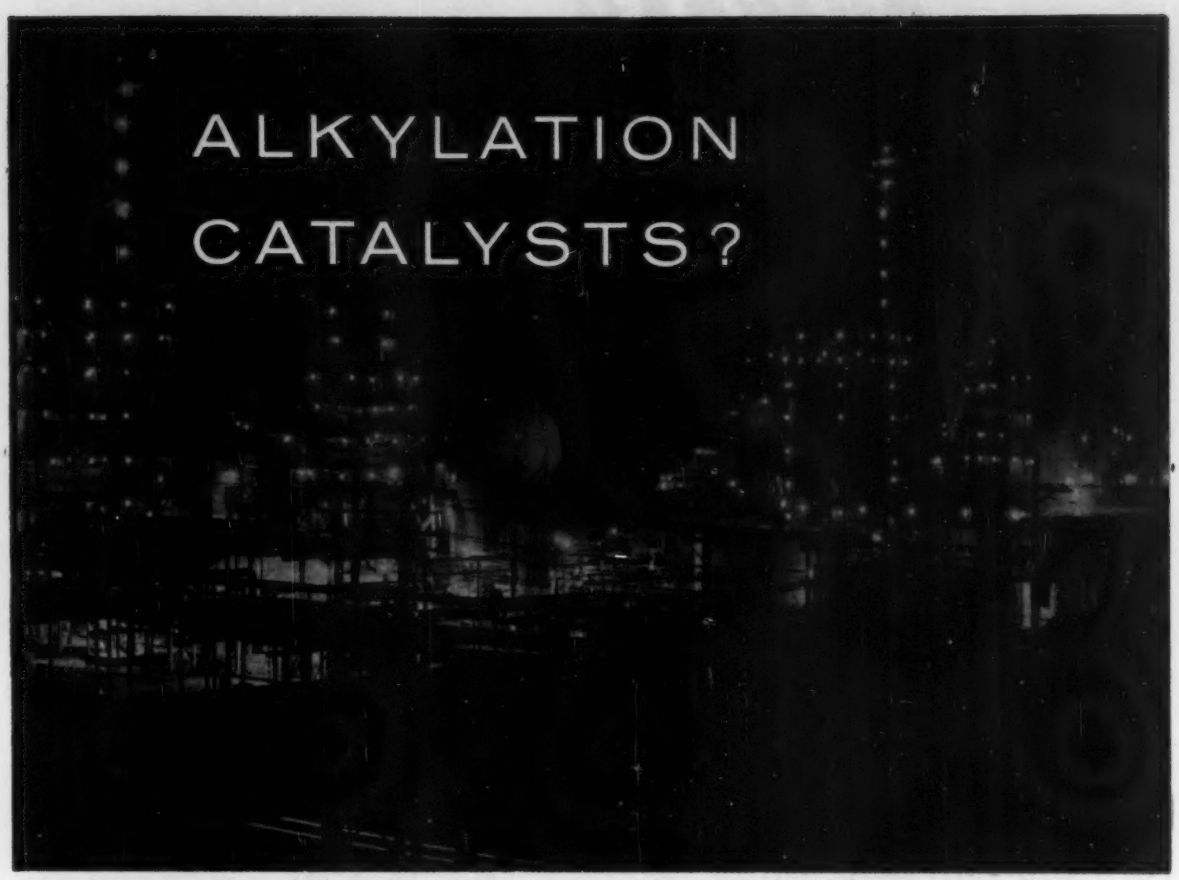


Why General Chemical is your best source of

ANHYDROUS HF and H_2SO_4

Whether you use anhydrous hydrofluoric acid or sulfuric acid as an alkylation catalyst, consider these advantages in ordering from General Chemical . . .

Large production: General Chemical is America's primary producer of both hydrofluoric acid and sulfuric acid. Our nation-wide network of strategically located plants assures you of steady, dependable service and supply.

Anhydrous hydrofluoric acid is produced at *3* General Chemical plants:

Baton Rouge, **Louisiana**
Marcus Hook, **Pennsylvania**
Nitro, **West Virginia**

Sulfuric acid is produced at *18* General Chemical locations:

Anacortes, **Washington***
Baton Rouge, **Louisiana***
Buffalo, **New York***
Cleveland, **Ohio**
Denver, **Colorado***
East St. Louis, **Illinois***
El Segundo (Los Angeles), **California***
Elizabeth, **New Jersey***
Front Royal, **Virginia**
Hegewisch (Chicago), **Illinois***
Newell, **Pennsylvania***
Nitro, **West Virginia**
No. Claymont, **Delaware***
Painesville, **Ohio**
Port Chicago (San Francisco), **California***
Pulaski, **Virginia**
Richmond (San Francisco), **California***
River Rouge, **Michigan***

***Spent acid recovery:** Of General's 18 sulfuric acid plants, 13 plants (starred in list above) are equipped to handle alkylation spent. These plants provide unmatched experience, service and facilities in recovery of spent acid. Behind them stand the resources and experience of Allied Chemical's General Chemical Division—pioneer in recovery of sulfuric waste products.

Technical assistance: General Chemical is prepared to provide you with expert technical service based on long experience with the application of sulfuric and anhydrous hydrofluoric acids as alkylation catalysts. Our Technical Service Department will be glad to advise you on such topics as methods of handling and storage, materials of construction, techniques and economics of spent acid recovery.

Basic to America's Progress

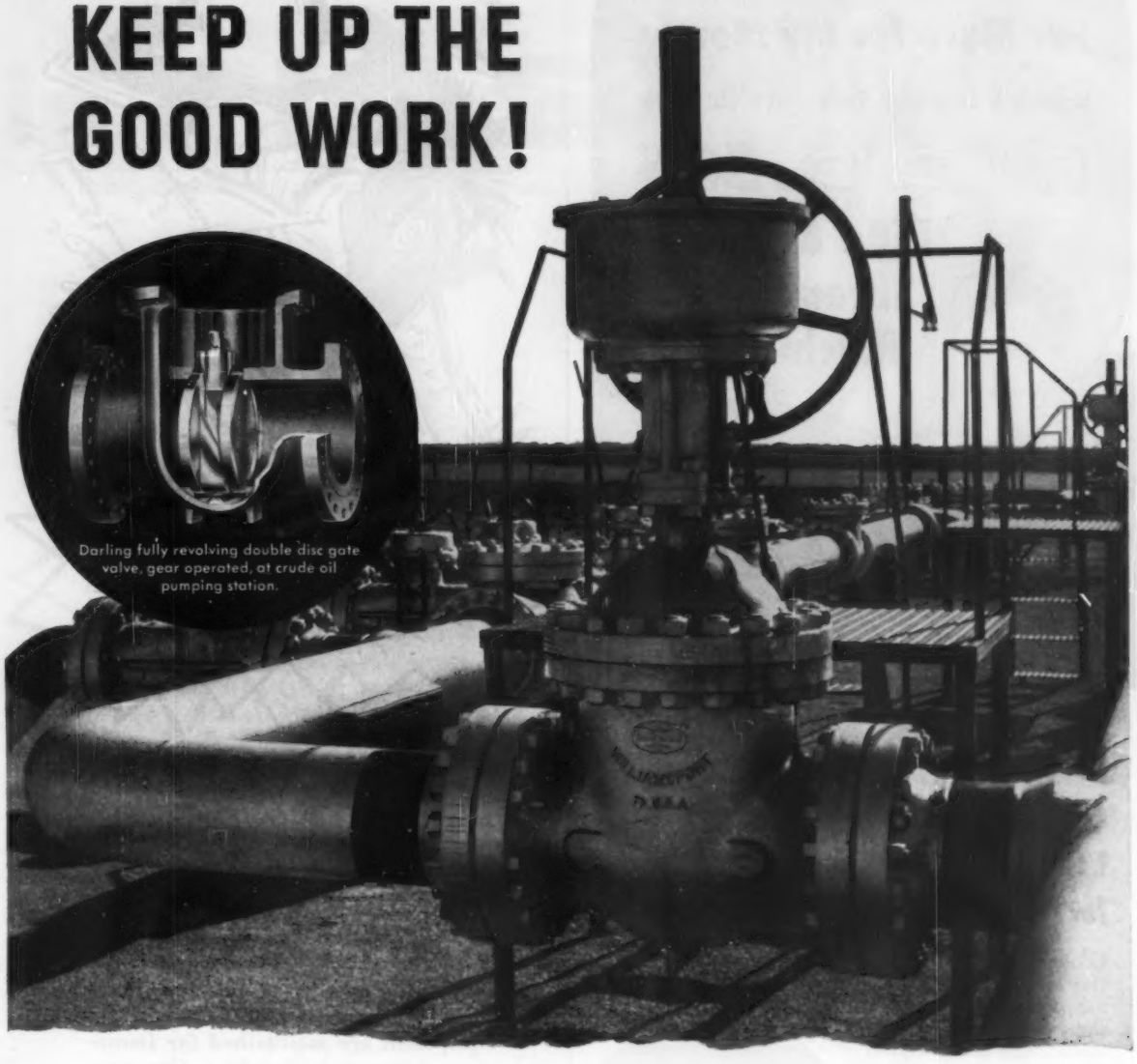
Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

This Darling gate valve feature can help you

KEEP UP THE GOOD WORK!



Almost all gate valves start out doing a good job. But it's very doubtful if *any* others can match Darlings for prolonged easy closure and freedom from downtime.

It's largely the Darling *fully revolving double discs with parallel seats* (shown above) that make the difference! This principle minimizes friction and uniformly distributes whatever wear there is. What's more these valves can "live" with the line stresses and surges that cause other valves to fail.

Why not get more familiar with how these Darling valves perform and what they offer you in avoiding trouble and downtime? Simply ask for Catalog No. 57.

DARLING VALVES

DARLING VALVE & MANUFACTURING CO.

Williamsport 31, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ont.

For more data on advertised products, use Readers' Service Cards, last page.

Complete with
1 Universal Die Head, 2 Sets of Dies for ½" to 2" pipe or conduit

Looks good, does better. Perfect cutting, reaming, threading fast . . . and easy! Three tools operate independently . . . swing up out of the way for short pipe chucking from front. Slip-proof Speed Chuck is a great performer. Concealed oil system, automatic shut-off nozzle. Quick-opening die head sets to size right in machine. Power?. . . RIDGID-built motor handles 2" pipe, conduit, bolt, rod—and 12" geared tools easily. Try it, compare it . . . and you'll understand its enormous popularity! Leg and wheel stands available. At your Supply House.

The Ridge Tool Company Elyria, Ohio, U.S.A.

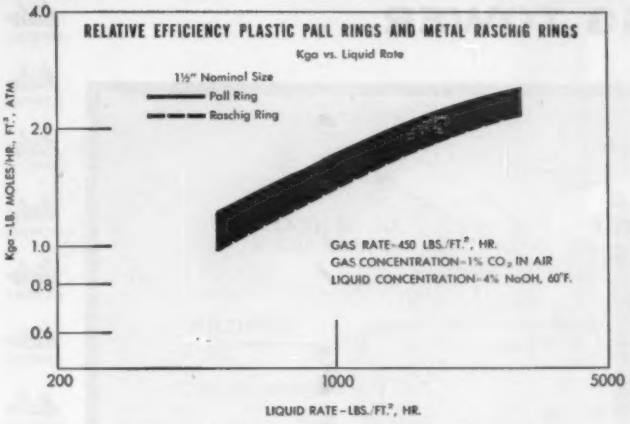
THREADED PIPE... *It's Tight... It's Best... Costs Less!*

over multiple source buying of YOUR laboratory needs

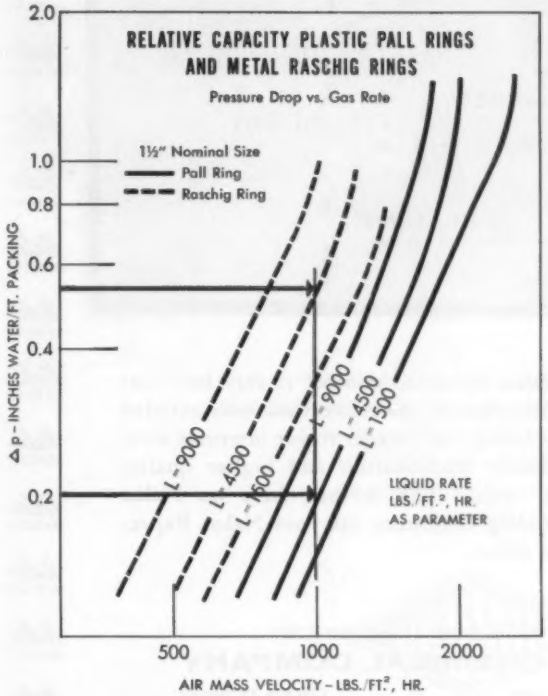
Make Curtin your one reliable source for laboratory supplies. Complete stocks of quality laboratory equipment are maintained for immediate delivery at supply points strategically located in all major refining areas. Technical and Repair Services are readily available all the time to help with your specific problems. Call Curtin on your next laboratory order and get "everything at one source."

W. H. CURTIN & CO.
DOMESTIC EXPORT • CURTIN PETROLEUM TESTING EQUIPMENT
HOUSTON - DALLAS - NEW ORLEANS - JACKSONVILLE
Sales Offices: TULSA • BIRMINGHAM • CORPUS CHRISTI
Subsidiary: CURTIN DE MEXICO, S.A. de C.V., MEXICO CITY
Established 1922 U.S.A.

NOW PALL RINGS in PLASTIC



Kga data, obtained in one of our 30" experimental towers, reflects the much greater efficiency of plastic Pall Rings.



Pressure drop data likewise reflects the high capacity of plastic Pall Rings. For example, pressure drop through metal Raschig Rings at a gas rate of 1000 lbs./ft.², hr., and a liquid rate of 4500 lbs./ft.², hr., is almost three times greater than through plastic Pall Rings.

The remarkably efficient Pall Ring, first introduced on the American market in 1957, in metal, is now available in polypropylene and high density polyethylene;* in four sizes: ⅝", 1", 1½" and 2".

Pall Rings in plastic offer the same striking advantages of low pressure drop and high capacity at less than one-fourth the weight. (For example, 1½" Pall Rings in carbon steel weigh approximately 23½ lbs. per cu. ft. In plastic, only 4¼ lbs.)

Take a look at the graphs showing comparative efficiency data and capacity data for metal Raschig Rings and plastic Pall Rings . . . data prepared from test runs in one of our 30" diameter experimental towers. The differences stem entirely from the characteristics of the two rings. In the Pall Ring the inner projections of the wall become active working surfaces as opposed to the relatively "dead" inner wall of the Raschig Ring.

The conclusions are inevitable: tower volume can be substantially reduced by using Pall Rings (either metal or plastic) in place of Raschig Rings.

***On special order, Plastic Pall Rings can also be supplied in PVC and polystyrene.**

OUR 100th YEAR

U. S. STONEWARE

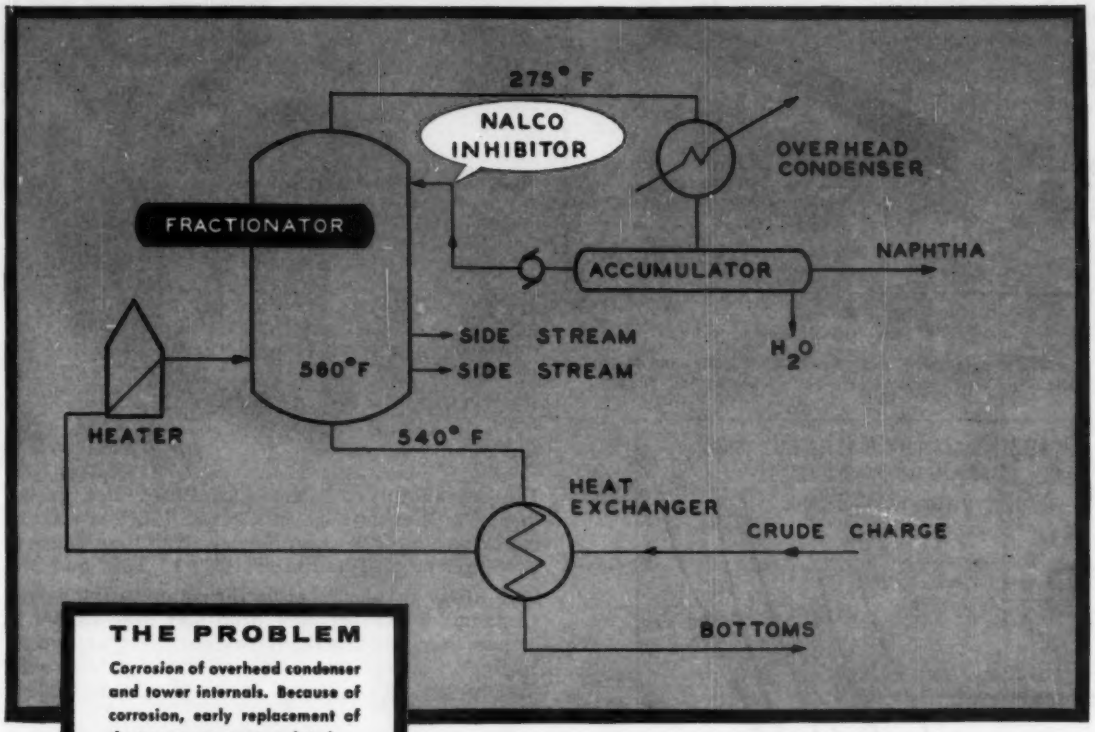
AKRON 9, OHIO

NEW YORK • CHICAGO • HOUSTON • LOS ANGELES

65-0

For more data on advertised products, use Readers' Service Cards, last page.

HOW *Nalco* INHIBITORS CUT DOWNTIME 74% ...AND SAVED THIS FRACTIONATING TOWER



THE PROBLEM

Corrosion of overhead condenser and tower internals. Because of corrosion, early replacement of the tower was contemplated.

THE TREATMENT

Nalco Corrosion and Fouling Inhibitor applied into overhead reflux.

THE RESULT

In this case only one point of application protected both fractionator and overhead equipment. Iron in accumulator water brought below 0.5 ppm as compared to previous 100-150 ppm. Corrosion and plugging stopped, tower saved, and downtime for cleaning reduced by 74%.

EFFECTIVE Nalco corrosion control is very low-cost protection. For example, this refinery not only avoided the cost of a new tower, but cleaner tower internals actually resulted in better fractionation and higher quality products. If you would like further facts on Nalco Corrosion and Fouling Inhibitors, ask your Nalco Representative or write direct.

National Aluminate Corporation is now

NALCO CHEMICAL COMPANY

6259 West 66th Place • Chicago 38, Illinois

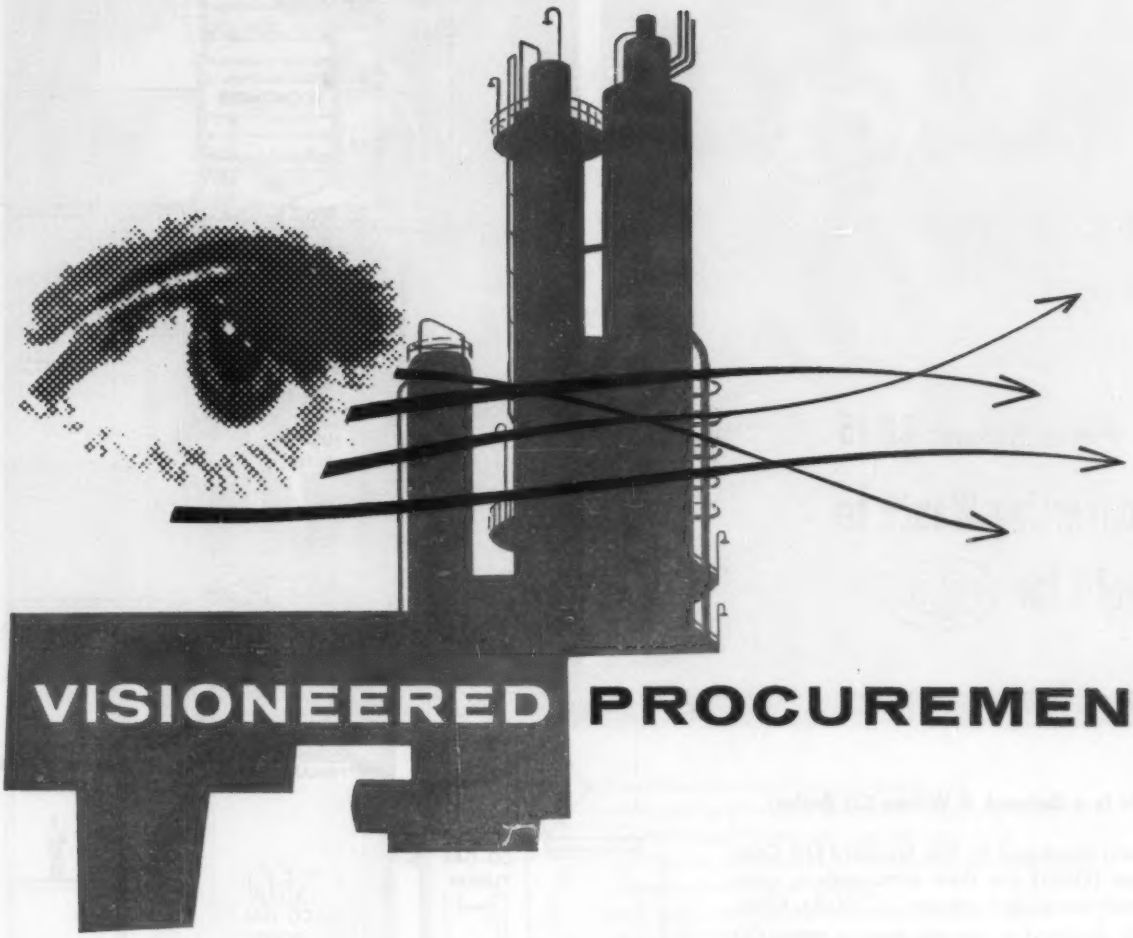
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany

In Canada—Alchem Limited, Burlington, Ontario

THE *Nalco* ® SYSTEM ...SERVING INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

Nalco CHEMICALS

intangibles were never so important



VISIONEERED PROCUREMENT

Procuring the innumerable items for construction of a petroleum, chemical or petrochemical plant is a complex undertaking requiring a high degree of experience and foresight. Working in close coordination with estimating, engineering, drafting, field construction, inspection and expediting personnel, the Procon purchasing staff provides many intangible services of inestimable value. This is another reason why a Procon-built plant is economical in cost, completed on time and superior in performance!

PROCON®

PROCON *Incorporated*

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

PROCON (CANADA) LIMITED, TORONTO 18, ONTARIO, CANADA

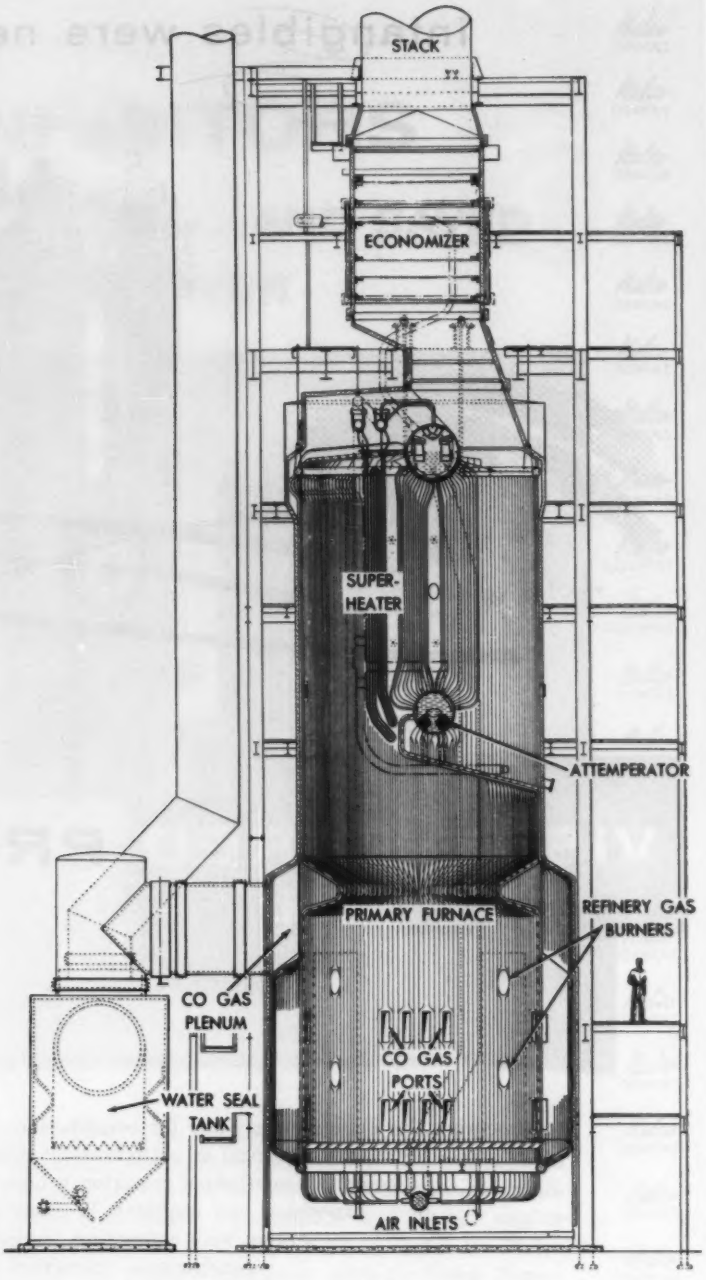
PROCON (GREAT BRITAIN) LIMITED, LONDON, W. C. 2, ENGLAND

PROCON INTERNATIONAL S. A., SANTIAGO DE CUBA

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

Refinery Report: **CO 15**

Converting Waste to profit for SOHIO



This is a Babcock & Wilcox CO Boiler.

It was purchased by The Standard Oil Company (Ohio) for their ultra-modern, completely-integrated refinery in Toledo, Ohio.

It is designed to use the heat in waste CO gases from the cracking unit to generate steam for the refinery's power and process needs.

It does just that. Hour after hour. Day after day. Week after week. Dependably and efficiently.

It will save enough fuel to pay for itself in less than 3 years.

Probably, a B&W CO Boiler can do the same for your refinery.

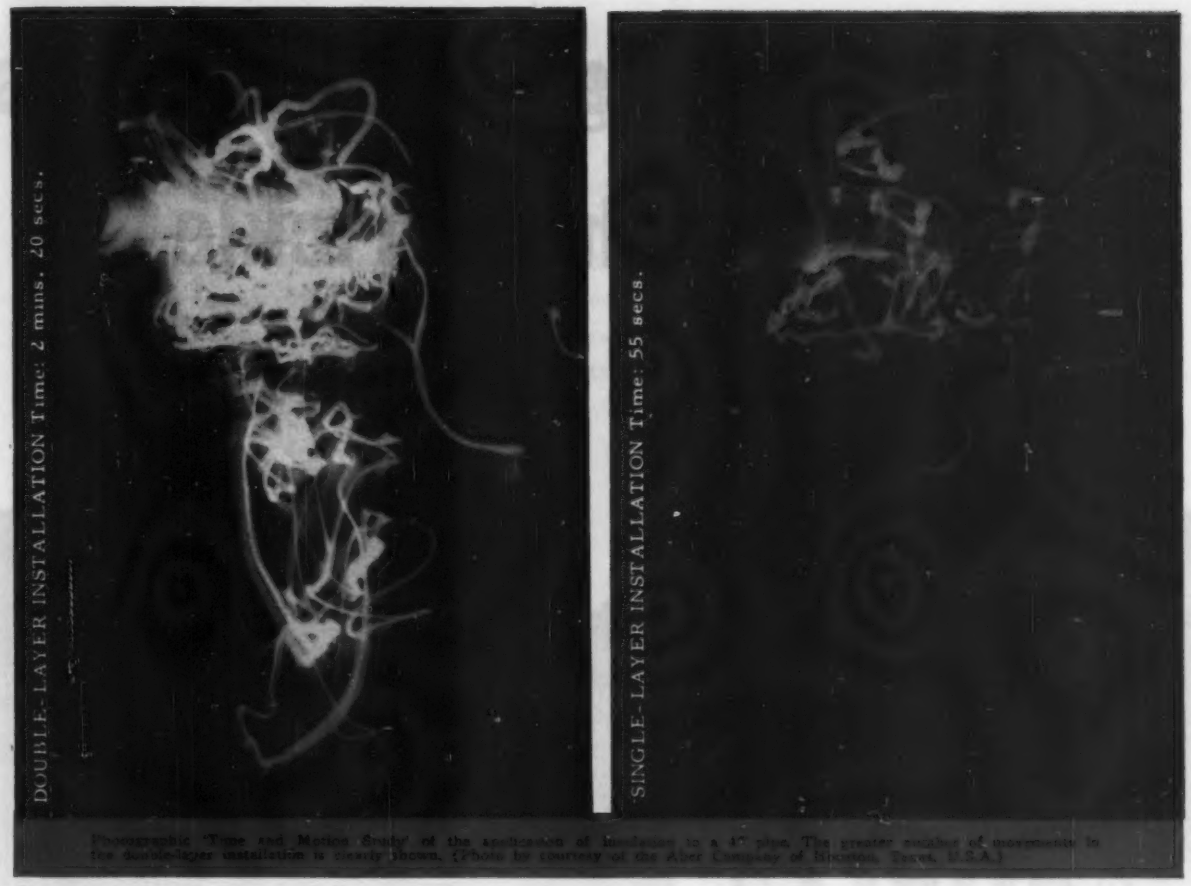
Find out. Write us today. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

CO-103



Photographic 'Time and Motion Study' of the application of insulation to a 4" pipe. The greater number of movements in the double-layer installation is clearly shown. (Photo by courtesy of the Aber Company of Wisconsin, Dover, U.S.A.)

One layer— Less work

CAPOSITE single-layer insulation

Insulation in a single layer! Caposite was developed by The Cape Asbestos Company to avoid the 'two-layer compromise' Caposite does it in one—saving considerably on installation time and costs. Caposite, the amosite asbestos insulation, is designed to withstand temperatures up to 1000° F. without loss of efficiency.

LOW JOINT LOSS

The fibrous edges of Caposite knit together at the joints giving a good heat seal and making staggered joints unnecessary.

EASY TO HANDLE

Its inherent strength makes it possible to handle Caposite in large sections for example at 2" thick for 30" n.p.s.—with very little damage and a further saving in installation costs.

CAPE

THE CAPE ASBESTOS COMPANY LIMITED 114 & 116 Park Street, London W. 1, Grosvenor 6022
Cables: Incorrupt London

Enquiries in Canada to: Cape Asbestos (Canada) Limited, 200 Bloor Street East, Toronto, Ontario.
U.S.A.: North American Asbestos Corporation, Board of Trade Building, Chicago 4, Illinois.

TA 2543

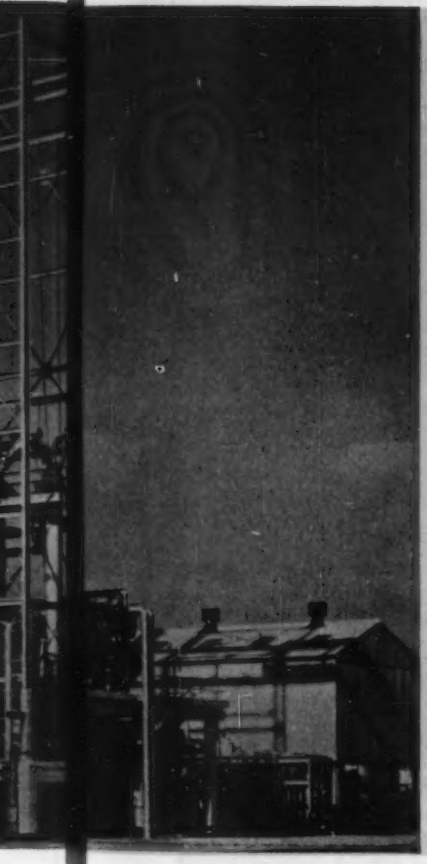
For more data on advertised products, use Readers' Service Cards, last page.

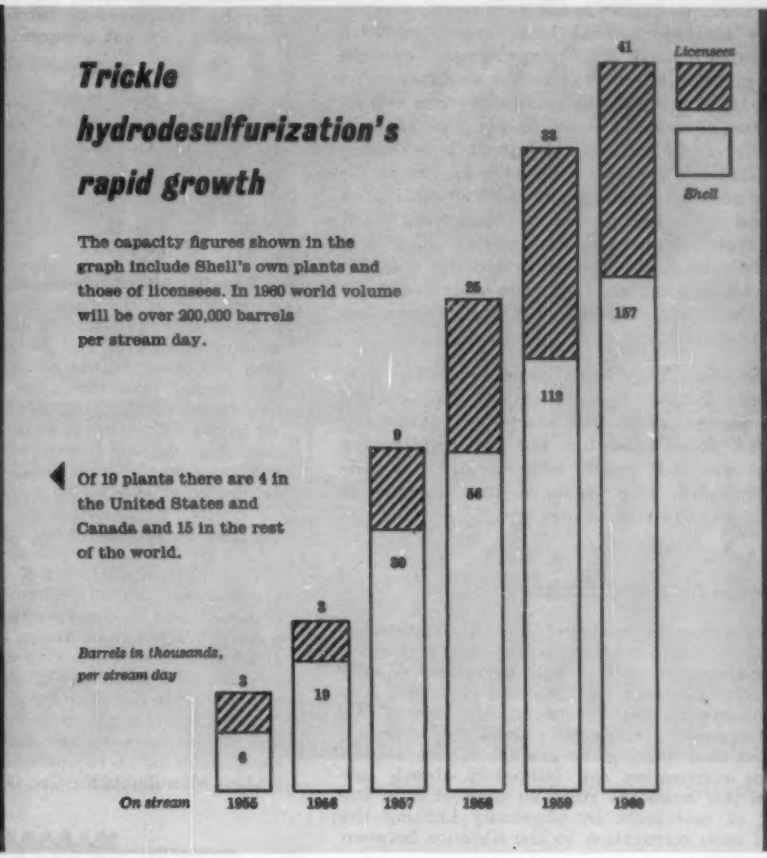
Outstanding performance

Shell Trickle Process

and economy with

Substantial economies in both capital and operating costs result from relatively low hydrogen recycle rates with only part of the charge vaporized. Sulfur elimination of 85-90% from middle distillates is readily achieved. The process provides notably long runs between infrequent catalyst regenerations to initial activity. Although used commercially for the first time only in 1955, Shell's Trickle Hydrodesulfurization Process is now widely accepted in the industry.





hydrodesulfurization

There is also available a Shell process for the vapor phase hydrodesulfurization of light fractions

Inquiries should be addressed, for plant locations in U.S. and Canada, to: Shell Development Company, 50 West 50th Street, New York 20, N. Y. Elsewhere to: Bataafse Internationale Petroleum Maatschappij N.V., 30 Carel van Bylandtlaan, The Hague, The Netherlands (P.O. Box 162).

For more data on advertised products, use Readers' Service Cards, last page.

Expansion Joint Design Moves out of the "Model T" Era

Badger first began fabricating packless metal bellows expansion joints more than 35 years ago. These "Model T" joints performed (and are still performing) with outstanding success in hundreds of process and steam line piping installations.

Starting in the 30's other expansion joint manufacturers entered the field. The most successful adopted many of the basic features of the original Badger design.

During the last decade, as industry's requirements became more stringent, and joint manufacturers gained fabricating and field experience, certain fundamental problems inherent in the early designs became evident. Most of these problems were solved through a series of modifications. (Among which was the Badger Directed Flexing Self-Equalizing Joint — the famous "DFSE" Design.) But, at best, the modifications were stop-gap measures which complicated the joints and greatly increased their weight. A fundamental reassessment of expansion joint engineering data was needed. Badger led the way: In 1956, a task force completed a three-year research program and the first S-R (Service-Rated) Expansion Joints were produced.

In the three years they have been available, S-R Expansion Joints have been both an engineering and a sales success. But like many revolutionary concepts which upset tradition, the full implication of the advantages S-R Joints offer is still not universally understood. The message that follows is an attempt "to set the record straight."

• • • • •

Equalization — fact and fiction

Many users of expansion joints are under the impression that the so-called "equalizing" rings on today's conventional type expansion joints distribute movement equally among all the corrugations of the bellows. It is argued that as the joint absorbs thermal movement, the tops of the rings progressively come into contact until the bellows is fully compressed thus limiting the amount of compression which any one corrugation can ultimately absorb (see diagram 1). In *this* sense the rings do contribute to the "equalization" of movement by physically limiting the compression of each corrugation to the distance between any two adjacent rings.

Diagram 1

Conventional Type Expansion Joint. Cross-sections of rings and bellows of a conventional "self-equalizing" joint showing cold and hot positions. Note that true equalization of movement can only be obtained when tops of all rings are in contact — an impractical and dangerous situation.

Note, however, that the degree of compression will not be truly equalized until the tops of all the rings are in contact. But, when such a condition occurs, serious problems will result. If the limit of compressibility is reached before the thermal expansion has been completely absorbed, exceedingly large forces will be transmitted through the pipe line to the anchors and connected equipment. On the other hand, if the joint is compressed only partially, not all of the corrugations will absorb movement to the same degree.

How S-R Joints solve equalization problem

Badger S-R Expansion Joints feature the new Curvilinear Corrugations which naturally assume an "all curve" shape under pressure (diagram 2), assuring more equal distribution of stresses throughout the bellows material. Furthermore, the shape, height and pitch of the corrugations are based on a carefully engineered correlation. Thus, reasonably equal distribution of movement among the corrugations is obtained, even in joints not equipped with reinforcing rings.

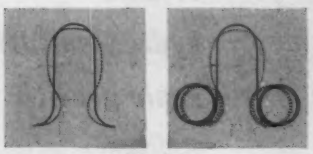


Diagram 2

Badger S-R Expansion Joint. Cross-sections of S-R Joints (Series 50 left, Series 150 right). The movement of the corrugations is shown by dotted and solid lines. Compare configuration and effective height of corrugations, position and size of rings with conventional joint.

Equalization of movement is inherent in the design and functioning of the bellows on Badger S-R Joints. On the basis of provable engineering criteria, the prime purpose of reinforcing rings of any design is to retain the hoop dimension (diameter) of the corrugations when they are subject to internal pressure. This Badger's simple, lightweight tubular reinforcing rings do. But, in addition, the new tubular shape of the rings does contribute to joint flexibility and life by permitting flexing over a more effective portion of the total corrugation height than conventional cast or fabricated equalizing rings.

Better performance, lower cost

Briefly, then, Badger S-R Joints alone offer these advantages: Better equalization of movement which results in elimination of localized stresses and leads to longer joint life; a simple, lightweight design that makes installation easier, eliminates cumbersome castings and fragile mechanical devices; complete range of sizes from 3" to 72" made from any workable metal and with a wide choice of accessories.

Badger S-R Joints are probably the answer to your problem. There's an easy and quick way to find out — ask the Badgerman for his recommendations. Write or phone today. Badger Manufacturing Co., 230 Bent St., Cambridge, Mass.

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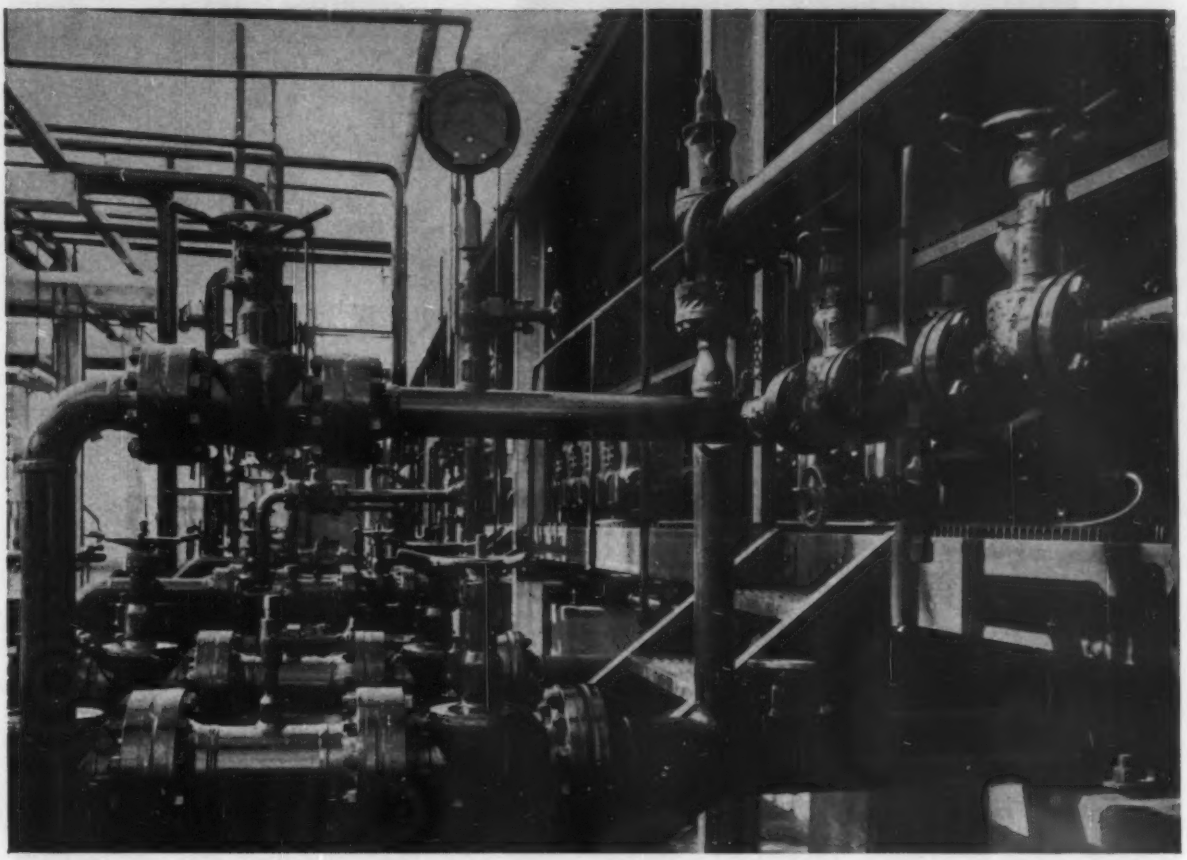
BADGER S·R EXPANSION JOINTS

START

USING ORBIT FORGED STEEL VALVES IN YOUR PROCESS AREA FROM FORMATION TO FINISHED PRODUCT

There are no voids or cavities in the body or bonnet of an Orbit Forged Steel Valve where pressures can build up from trapped fluids or gases when the valve is either in open or closed position. Body and bonnet is all forged steel, vapor-tight construction.

Stem packing chamber has great depth and capacity for easier adjustment and longer life of the packing. Stem packing is pliable and adjustable and can be added to or adjusted while the valve is in service and under pressure.



Orbit Valves in Typical Platformer Service Handling Recycle Hydrogen Gas at Approximately 500 psig and 100° F.

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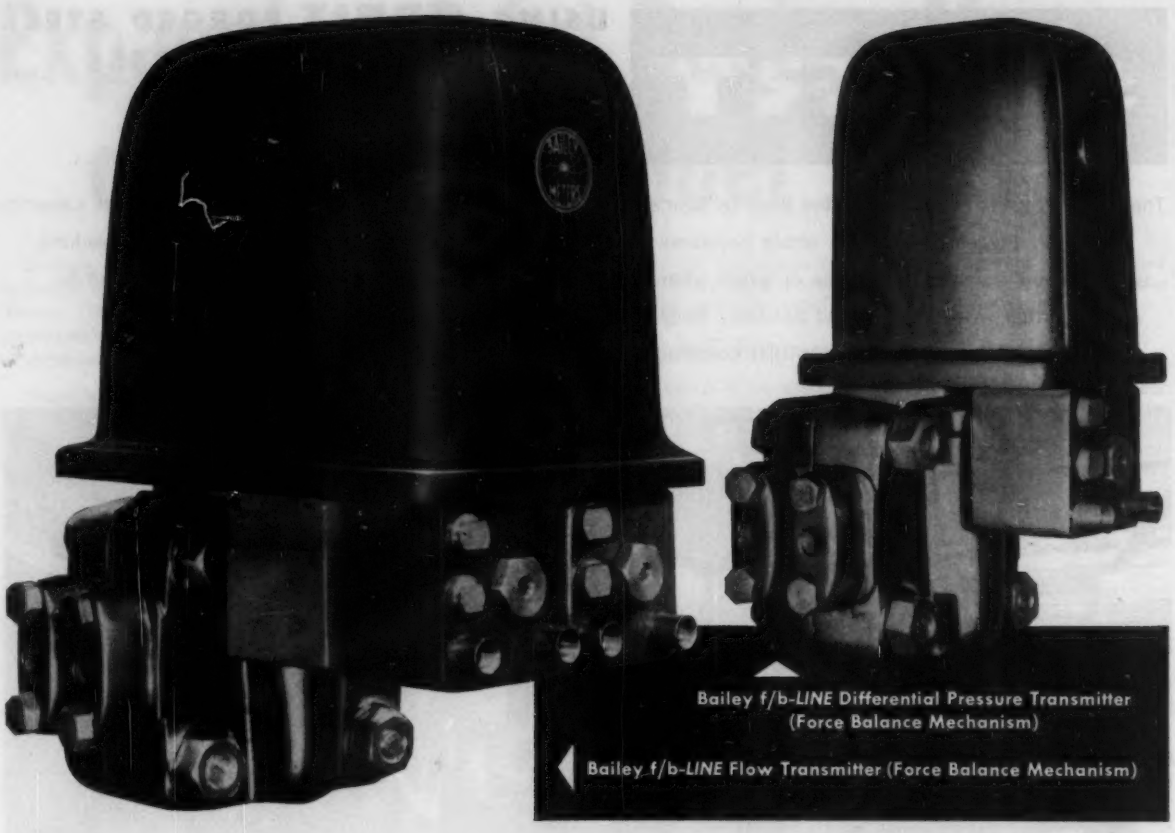

Bailey f/b-*LINE* Differential Pressure Transmitter (Force Balance Mechanism)

Bailey f/b-*LINE* Flow Transmitter (Force Balance Mechanism)

Two new Bailey *f/b-LINE* Transmitters

permit new accuracy in measuring flow and differential pressure

Pneumatically transmits rate of flow—or differential pressure—measurements to indicating, recording, and/or controlling equipment at remote stations. Transmitters consist of a diaphragm measuring mechanism and a force balance pneumatic transmitting unit.

APPLICATION

For steam, water, air, gases and other fluids producing differentials across primary elements from 0-2 in. H_2O to 0-2000 in. H_2O at maximum service pressure of 50, 1500, and 5000 psig.

FEATURES

Transmits a Signal Directly Proportional to Rate of Flow. Uses receiver with uniformly-graduated chart or scale. Eliminates need for external square-root extractors or characterizers.

10 to 1 Turndown. Differential range of each diaphragm measuring element may be changed by factor of 10 to 1; e.g., 0-20 in. H_2O diaphragm may also measure 0-2 in. H_2O.

Screwdriver Adjustments. Range and zero adjustments readily accessible. Range may be changed with screwdriver adjustment.

Overpressure Protection. Protects against full service pressure applied to either side of diaphragm.

Fast Response. No viscous dampers needed, so speed of response is very fast.

Corrosion Resistant. For maximum differentials between 20 and 2000" H_2O, all parts in contact with process fluid may be stainless steel. No sealing fluids or sealing diaphragm required.

Good Stability. Reset type boosters give good stability with high gain.

Versatile Mounting. May be mounted on process piping, wall, or separate mounting pipe using same bracket.

For additional information, call your local Bailey District Office, or write direct.

Chemical and petroleum division

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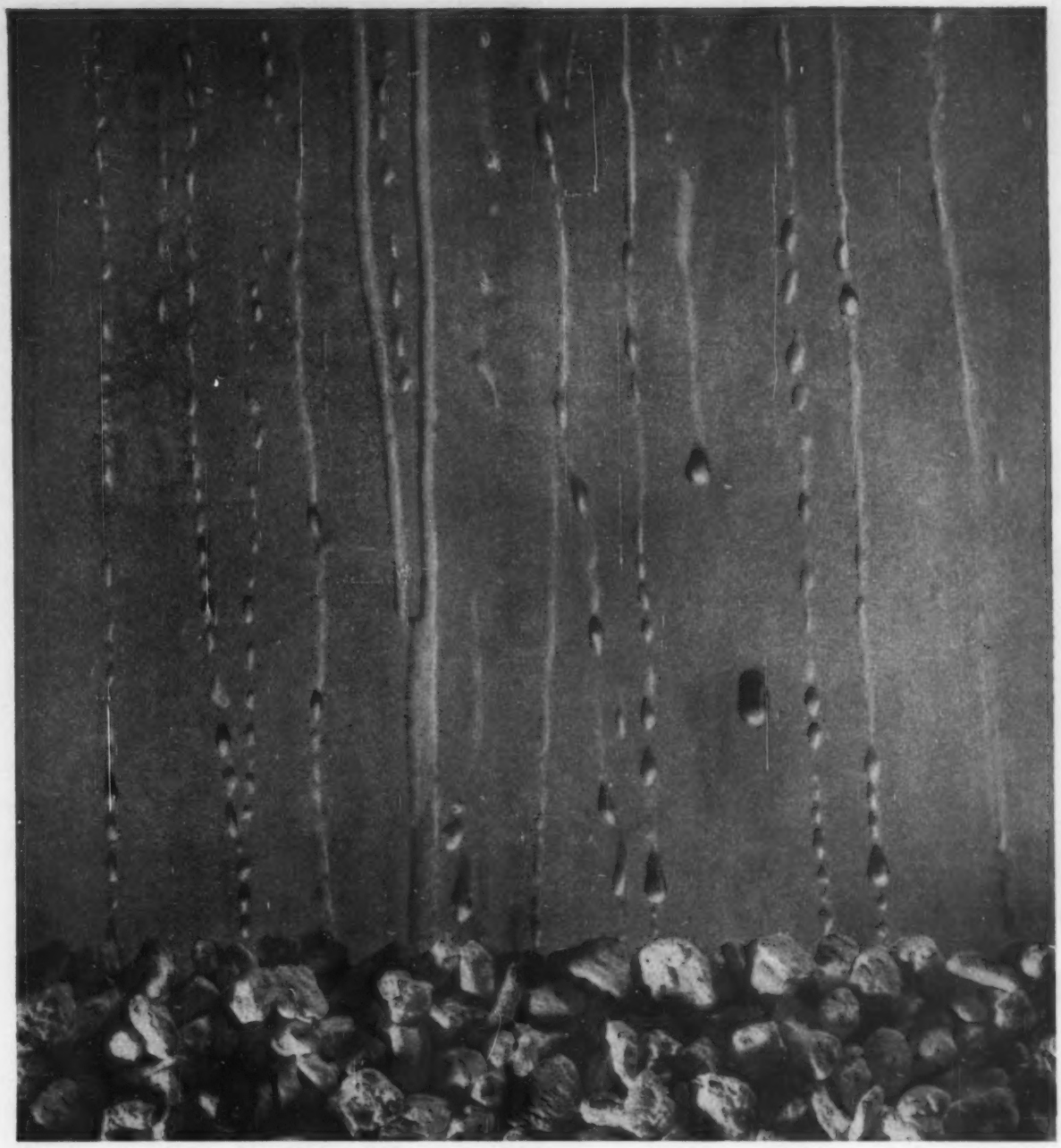

Unwanted water may ruin your product or process unless you

mix imagination with Alcoa Activated Aluminas

Water you can't remove is a sure bet to destroy the efficiency of a process or the quality of a product, or corrode the equipment. But you can count on drying up the last drop of unwanted water when you mix imagination and engineering with ALCOA® Activated Alumina. Here is the oldest, most thoroughly proved drying agent available. It makes possible dew points to minus 100°F and below. And because it can be saturated and reactivated almost endlessly without loss of capacity, it cuts drying costs substantially. See how quickly it can solve *your* dehydration problems. You'll join the thousands who've discovered it pays to *mix imagination with Alcoa Aluminas . . . to make a new product or process possible, an old product or process better.* To get product details, outline your desiccant application in a letter to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 708-M Alcoa Building, Pittsburgh 19, Pennsylvania.

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For exciting drama, watch "Alcoa Theatre," alternate Mondays, NBC-TV, and "Alcoa Presents," every Tuesday, ABC-TV

For finer products . . . let Alcoa add new dimension to your creative thinking

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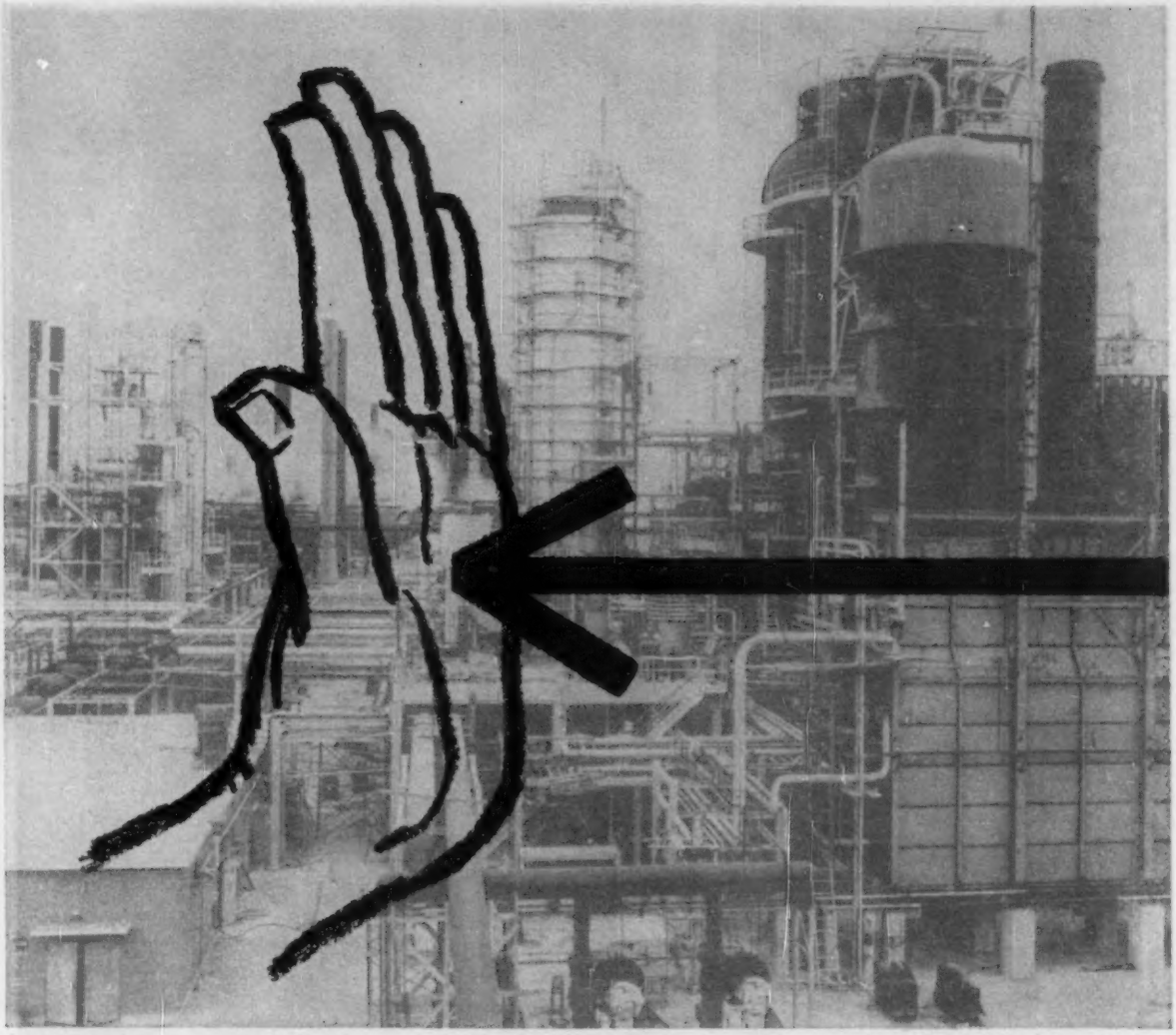

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. . . another virtue of ductile iron* Stanco Valves

Because ductile iron has a metallographic structure which resists leakage or seepage by liquids or gases, Stanco Valves made with this remarkable material are *pressure tight.*

But that's not all. They have thermal shock resistance equal to valves of cast carbon steels. Elevated temperature strength comparable to valves of cast steels. Corrosion resistance equal to valves of cast iron.

It all adds up to a story that's highly interesting to refinery engineers — a story with an exceedingly happy ending when the specifications get down to prices.

Whether your needs call for a production valve from Standard's broad line, or a special valve designed to your specific requirement, we think it will pay you to talk it over with people who are in the valve business from pattern making to testing. That's Stanco, of course.

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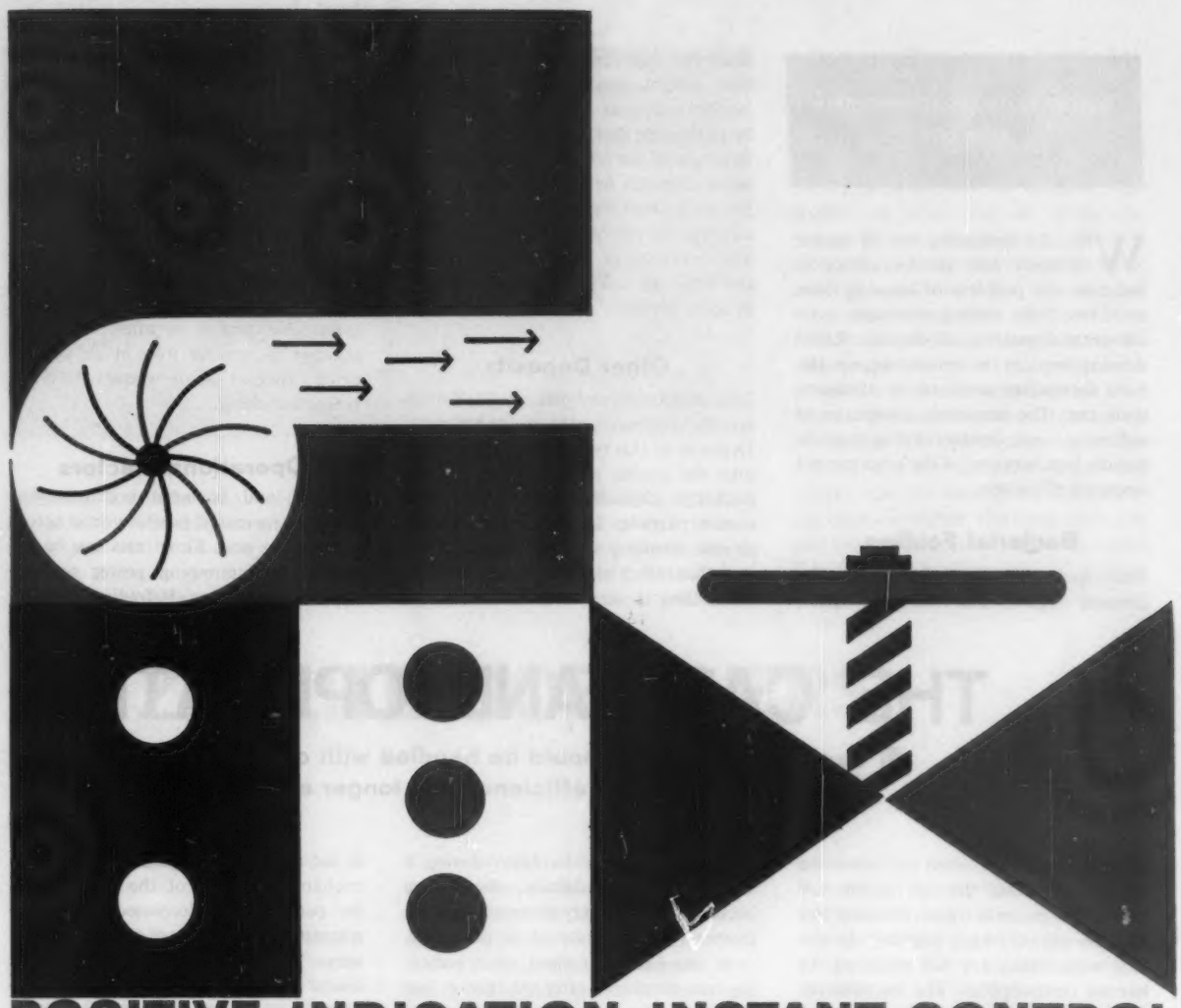

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S&J Gardtrol units continuously report actual conditions at remote points. They also allow instant change of conditions by the operator. Gardtrol Valve Monitor shows open, opening, closing, closed or stopped (partly closed) conditions. Gardtrol Pump Motor Monitor indicates on or off. Both have simple illuminated push button controls for all functions. Only one small wire—plus a common return—is needed between control unit and the field unit. S&J Gardtrol assures reliable supervisory control at lowest cost.

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SHAND AND JURS COMPANY 2600 Eighth Street, Berkeley, California

A Subsidiary of General Precision Equipment Corporation
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HELPFUL WATER CONDITIONING DATA FROM BETZ

THE CARE AND OPERATION

■ Exchange materials should be handled with care to maintain maximum efficiency and longer service life.

With the increasing use of zeolite softeners and demineralizers in industry, the problem of keeping these units free from fouling confronts more owners and operators all the time. Rapid developments in the ion exchange materials themselves continue to stimulate their use. The economic advantage of softening and demineralizing can be rapidly lost, however, if the units are not operated efficiently.

Bacterial Fouling

Municipal and industrial water supplies contain organic and mineral matter, some of which is filtered out when the waters are passed through zeolite softeners. The bacteria counts of many raw supplies are very high, particularly surface waters that are not prepared for human consumption. The bacteria encountered are chiefly soil organisms including such types as sulfate reducing bacteria, iron bacteria and various spore formers. Coliform bacteria are found occasionally in private well supplies.

Zeolite beds, in general, cannot support growth of bacteria in themselves. The organic matter that is filtered out by the zeolite, however, provides a source of food for reproduction of bacteria. Many times the pH, temperature and other environmental conditions in the softener are ideal for stimulating growth. Water with a low bacteria count can become heavily contaminated in passing through a badly fouled softener.

Bacteria produce slime which is voluminous and adherent and cannot always be removed by the action of regeneration and backwashing. The growths of slime and bacteria can impart objectionable taste and odor to the water. Even when the taste and odor are not objectionable, the slime can cover a significant portion of the zeolite so that regeneration is partially ineffective.

Surface supplies, to a greater extent than well supplies, contain high molecular weight organics. The organics, besides acting as food for bacteria can be of the type that slowly diffuse into the structure of the zeolite. Because the outward diffusion will be just as slow, the normally short regeneration period usually will not remove this type of fouling. The organics, in badly infested water, can build up and result in deterioration of some zeolites.

Other Deposits

Iron, aluminum, and manganese deposits are often encountered in zeolite softeners. Deposits of this type coat and penetrate into the zeolite particles reducing the exchange capacity of the unit. The coated particles can gradually increase in size resulting in large, hard masses and channeling of the softener bed. The channeling is very undesirable since it permits leakage of hardness during a softener run. In addition, the fouling becomes progressively worse as the effectiveness of the backwash is decreased.

At one particular plant, short softening runs developed after the zeolites had been in use for several years. Inspection revealed that the top six to eight inches of the softener bed was almost a completely solid mass. To break through the solid top layer a heavy crow bar was necessary. Below the solid layer large round balls, some eight inches in diameter, were found. Very little of the bed was in its original condition and it was difficult to believe that any softening could be accomplished by the unit. This case is undoubtedly an extreme one where the combination of a poor quality influent water and insufficient backwash rate made a premature replacement of the zeolite necessary.

Iron is probably the chief mineral enemy of zeolite material. Iron exists in various forms. In water supplies, such as deep wells, where oxygen is not present, iron exists in the ferrous state. In this form, iron is very soluble and can be exchanged as readily as divalent calcium and magnesium (the common hardness ions) in a softener.

If the water supply is aerated before softening, ferrous iron is oxidized to the insoluble ferric (trivalent) form. When ferrous iron is oxidized and there is insufficient time for its removal prior to softening, the insoluble ferric iron will not be exchanged by a zeolite but will be filtered out. For this reason, where it is necessary to soften a well supply containing iron, the softener should be located near the well and every effort made to keep air from entering the system. Preventing air leakage is sometimes impossible and it is often safer and cheaper to remove iron in an aerator or a special iron removal filter before softening.

Operational Factors

Mineral and bacterial accumulations cause an increased pressure drop across a softening unit. Flow rates can be decreased and pumping power requirements can increase. If fouling material is not removed at regular intervals, the exchange capacity of the softener can be permanently decreased. Increased quantities of regenerant are then necessary. The length of time required for backwashing and the quantity of backwash water is often increased. Rinsing is less effective in a badly fouled softener.

It should be kept in mind that a heavier fouling potential is imposed on softeners as the exchange capacities of the synthetic zeolite materials increase. That is, a unit of high capacity exchange resin generally filters a great deal more water between backwashes than the same unit of greensand. It becomes increasingly important, therefore, that close attention be given to the backwash and regeneration operation. If the period between regenerations is more than 24 hours and the quality of the influent water is inferior, or pressure drop across the unit is higher than normal, backwashing at more frequent intervals without regeneration will prove helpful.

Fouling of the softener can and often does lead to other disadvantages as well. Besides shorter softener runs, higher salt consumption and greater loss of zeolite mineral, the quality of the effluent will decrease with time. Where the softened water is used as makeup to boilers, internal treatment consumption will be

OF ZEOLITE SOFTENERS

TABLE I	CHARACTERISTICS OF CATION EXCHANGE MATERIALS			
Type of Material	Capacity gr. per cu. ft.	Regenerant lb./kgr.	Operating pH	Range Temp. °F.
SILICIOUS BASE				
Processed Greensand	2,500- 3,000	0.35-0.50	6.0- 8.4	135 Max.
High Capacity Greensand	5,000- 5,500	0.35-0.50	6.5- 8.1	110 Max.
Synthetic Gel	7,500-10,000	0.33-0.50	6.8- 8.2	100 Max.
ORGANIC				
Sulfonated Coal	6,000- 7,000	0.45	5.0-10.0	135 Max.
Polystyrene Resin	20,000-30,000	0.25-0.50	5.0-11.0	250 Max.

increased, a heavier accumulation of sludge will develop and increased blowdown rates will be necessary. Very frequently, excessive periods of rinsing must be used before a good quality effluent is produced, which is low in both hardness and chlorides.

Tables I and II list the common types of exchange materials used in zeolite softeners together with their exchange capacity and other operating characteristics. This information can be used as a guide in checking the operation of the zeolite unit to determine whether its efficiency has decreased. A daily log on softener operation should be maintained to accumulate the necessary data to permit checking of the softener efficiency.

TABLE II	FLOW RATES IN GALLONS PER SQ. FT. PER MINUTE			
	Backwash Rate	Regen. Rate	Rinse Rate	Oper. Rate
SILICIOUS BASE				
Processed Greensand	9	2.5	5	5
High Capacity Greensand	9	2.5	5	5
Synthetic Gel	4-6	2.5	5	5
ORGANIC				
Sulfonated Coal	6	1.5-3.0	2.5-6	6
Polystyrene Resin	6	2.5	2.5-7	7

The anticipated loss of exchange material is a maximum of 3% per year due to mechanical breakdown. With fouling this loss can be seriously increased. While the zeolite mineral is not a capital expense but rather a maintenance item, it nevertheless is important to minimize the cost of operation and a comprehensive program should be followed to assure minimum loss of resin, maximum salt efficiency and the continuous production of a good quality effluent. Such a program will pay dividends.

To assure efficient operation of the softener, the following items should be checked:

(1) Quality of the influent water.

(2) The backwash rate and quantity of backwash water used.

(3) Quantity of salt used per regeneration.

(4) Quantity of water softened between regenerations.

(5) Quantity and flow rate of water used for rinsing.

(6) Periodic examination of the softener and exchange material.

The correction of the problem may involve better clarification of the influent water. In some cases, revision of the backwash, regeneration or rinsing cycle or improvement of the distribution system may be necessary. Perhaps a periodic chemical cleaning with special cleaning agents may be all that is necessary.

However, if permanent damage has been done to the resin, then replacement of the material will be necessary. When replacements are necessary, the selection of one of the high capacity resins to replace greensand or the silicious type zeolite can often lead to substantial savings in salt requirements. Table I shows the comparison between capacity and salt requirements for various types of exchange materials. It should be noted that greater exchange capacities can be secured with the polystyrene resins at a lower salt consumption than with the greensands. It should further be noted that the polystyrene resins can tolerate a wider variation in pH and temperature. In many cases, the softening rates are higher with these materials and increased capacity can be an added benefit. The replacement of natural greensand with a polystyrene resin has resulted in as much as a 40% increase in softening rate and as high as a tenfold increase in softener capacity. The savings in both salt and labor attributed to operation of the softener can result in sufficient savings to pay for the replacement in less than two years.

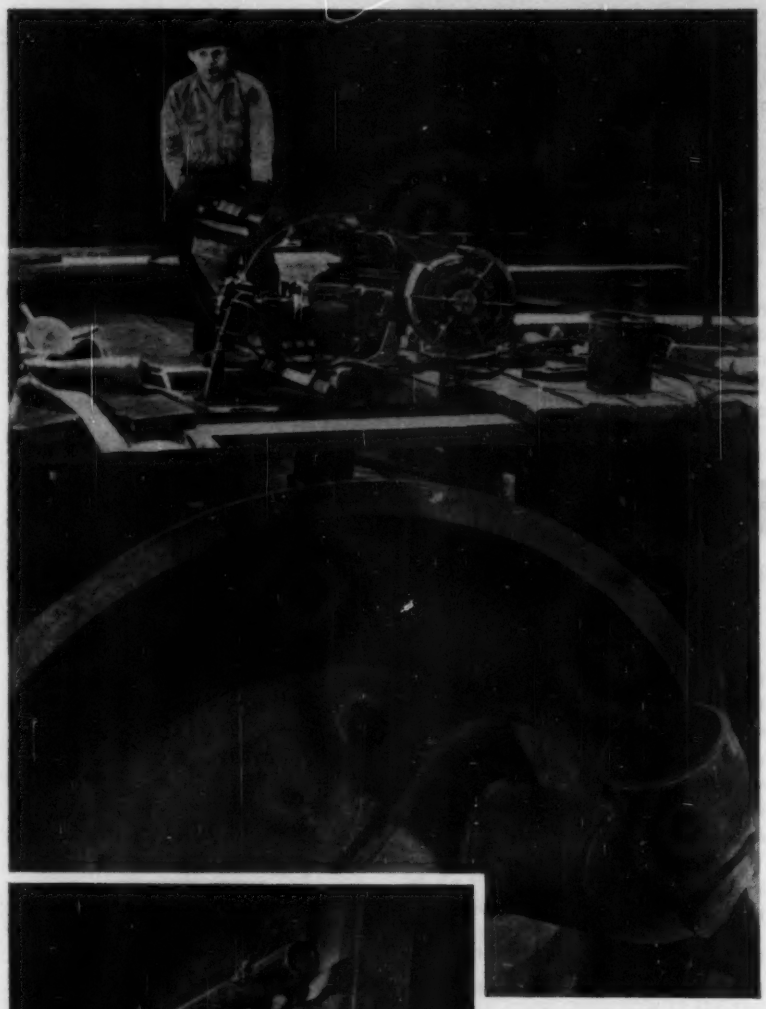
A BETZ Field Engineer will be pleased to discuss your zeolite softener problems, review operating conditions and offer recommendations for the proper mechanical or chemical correction to assure maximum efficiency. Should replacement of the bed be necessary, he will be pleased to recommend the proper BETZ Resin for your requirements.

BETZ LABORATORIES, INC.
Gillingham & Worth Streets • Phila. 24, Pa.

BETZ

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

At B-L-H the proof of the welding is in the testing... X-rays of giant pressure vessel showed not one defect!



Automatic submerged metal arc was one of three welding methods employed by B-L-H's Eddystone Division on this 100-ton vessel.

Chrome molybdenum steel 5 1/16 in. thick was carefully preheated prior to tack-welding. Shown is a profile of the joint, beveled by flame cutting between half-cylinders.

The 100-ton pressure vessel illustrated was fabricated at the B-L-H Eddystone Division by welding together two half-cylinders, 12 ft. long, 6 ft. in radius, and made of 5 1/16-in.-thick chrome moiybdenum steel. Then these had to be joined at top and bottom to hemispherical heads of the same material 2⅝ in. thick. The ends of the cylinder walls had to be tapered from the outside so that the walls and heads would be of the same thickness at the joint. Joint design for the longitudinal welds called for 64 passes to be built up in a balanced manner, first on one side of the cylinder wall, then on the other, to avoid uneven stresses.

Welding several nozzles to the heads presented some unusual problems. One such weld required 92 passes. In all, 13 kinds of steel ranging from ⅜ in. to 5 1/16 in. in thickness were used.

All root passes, all joints that were back-chipped, and all completed welds were examined by magnetic particle inspection. Also, as a requirement of the job, all welds in the piping and the vessels were subjected to a 100% radiographic inspection with 1-curie sources of cobalt-60. At this point the care and precision with which the welding had been planned and executed became dramatically evident. No defects were found and no repair welding was necessary.

Only a shop with Baldwin's wealth of skills and facilities could have handled this tough job so efficiently . . . so economically.

A copy of our illustrated Weldment Bulletin 7001 is yours for the asking.

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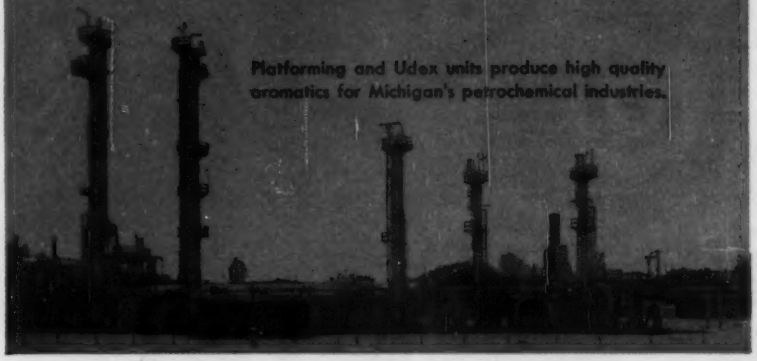
CPA-160(11-60)

Nightview of UOP Fluid Catalytic Cracking (left) and "HF" Alkylation units at Leonard's Alma (Mich.) refinery.

UOP Fluid Cat Cracker boosts production of gasoline and quality distillates



Platforming and Udex units produce high quality aromatics for Michigan's petrochemical industries.

Leonard upgrades blending stocks with new UOP Fluid Catalytic Cracking and "HF" Alkylation units

by Reid Brazell
President
Leonard Refineries, Inc.
Alma, Michigan

The question has been asked of me frequently: What has motivated Leonard's growth as one of Michigan's most successful petroleum operations? It has resulted, mainly, from the challenge of the times. Each phase of our development has been chronologically prologued by conditions which have made advancement imperative.

Reid Brazell

Early Improvement Increases Gasoline Yield 130%

Back in the mid-thirties, our chief problem as a newly formed company was to improve octane rating and consumer acceptance of Michigan refined gasoline, known then as the "bargain" gasoline. Low in price, it was also low in grade. Our first step was the installation of a then brand-new refining development, the UOP two-coil selective Thermal Cracking Unit—which enabled us to produce a more competive product and increase our gasoline yield from low-grade crude by 130%!

First "midget" UOP Polymerization unit provided 100-plus octane blending stock

The quality picture further improved immediately thereafter with the addition of one of the world's first "midget" Catalytic

Polymerization units. It went on stream at our Alma refinery and provided 40 BPSD of 100-plus octane blending stock and permitted Leonard to market an 80-octane gasoline.

Post-War Opportunities Foster New Facilities

The end of the war triggered another surge of growth by Leonard. First, a small catalytic cracking unit added another 3,000 BPSD of quality product to our output and this unit was later revamped to up capacity to 7,000 BPSD. An LPG plant was completed, a vacuum unit went on stream, treatment plants were completed and 648,000 barrels of tankage was erected.

Expansion took another giant step in 1955 with Leonard's acquisition of Mid-West Refineries and Roosevelt Oil & Refining Corp. A 1,200 BPSD UOP Udex® unit, tied into Roosevelt's catalytic reformer, increased Leonard's petrochemical business, enabling us to produce quality benzene and toluene for sale as chemical intermediates and solvents.

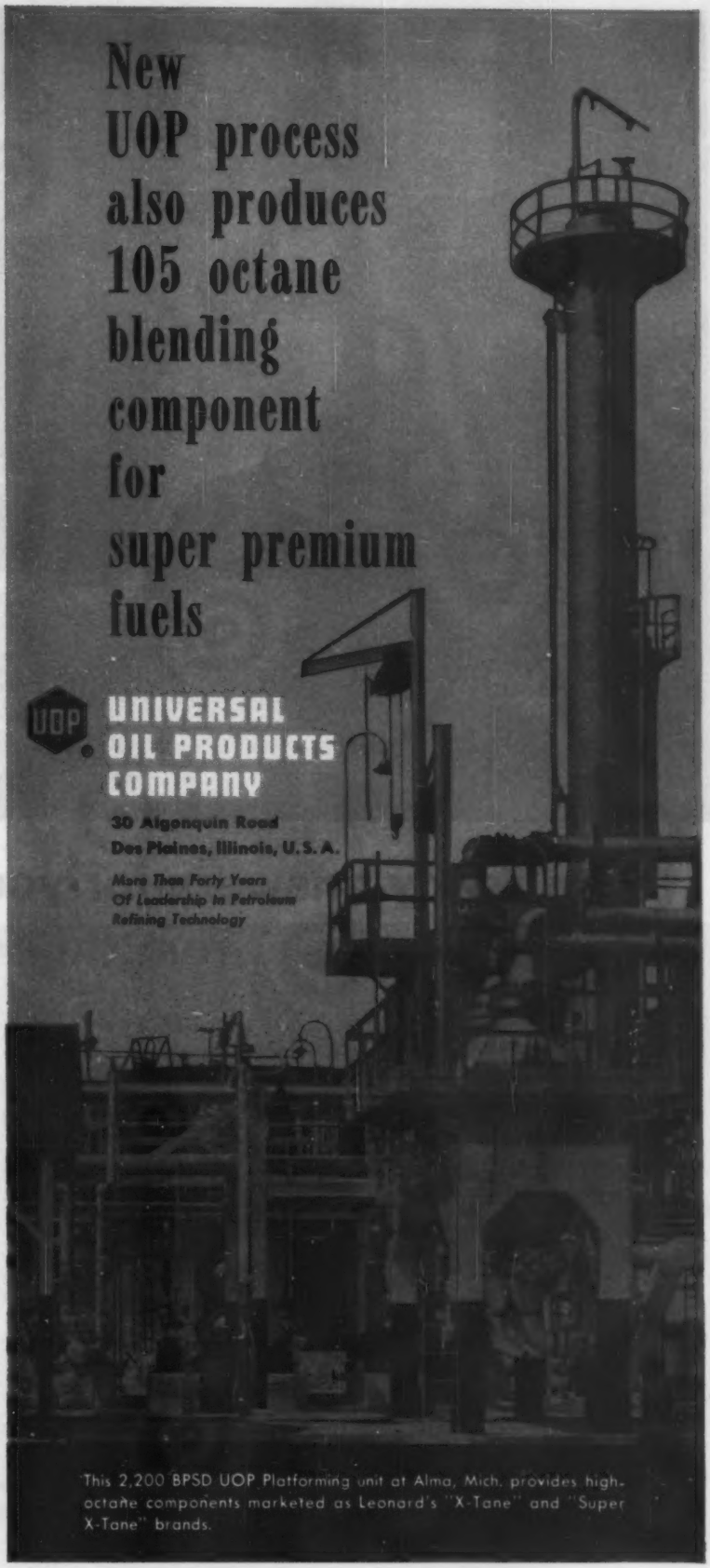
Fluid Catalytic Cracking, and "HF" Alkylation Units Added

Another "changing condition" took place in 1958 when construction of natural gas pipelines into Michigan cut into the demand for residual fuel oils. With our gasoline and domestic heating oil sales up, but industrial fuel oil sales down, we added a 7,500 BPSD UOP Fluid Catalytic Cracking unit to reduce residual stock and produce more gasoline and quality distillates.

Simultaneously, a 1,100 BPSD "HF" Alkylation unit, designed and licensed by Universal, went on stream at our Alma refinery. Producing a 105-octane blending component, the unit made possible a super-premium fuel of more than 100-octane.

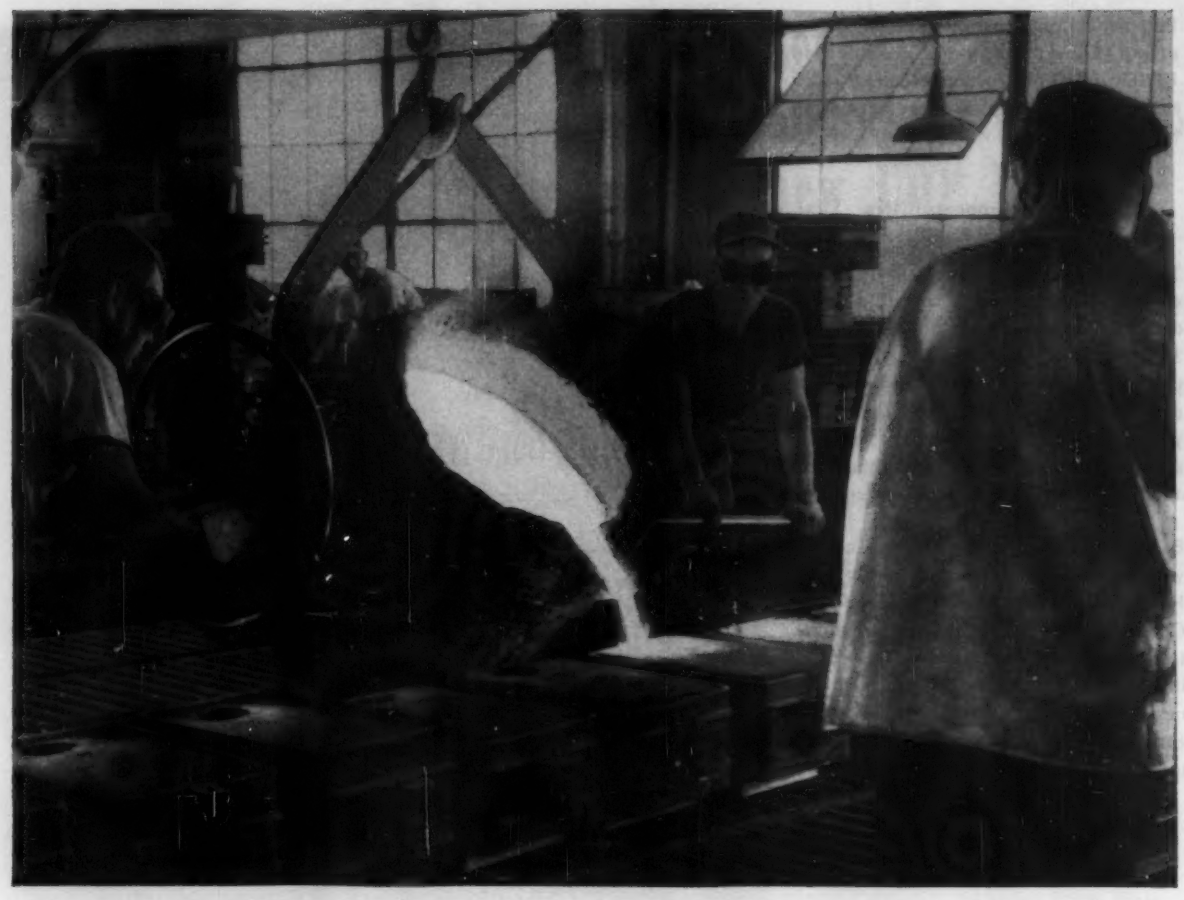
Today, Leonard's refineries total nearly 30,000 barrels per day of crude capacity. With a broad range of facilities encompassing UOP Catalytic Cracking, Vacuum Distillation, UOP Platforming®, Thermal Cracking, Udex extraction, "HF" Alkylation, Platreating* and Catalytic Polymerization, we stand ever watchful of "The Conditions of the Times" as a stimulus for future growth.

*Trademark



This 2,200 BPSD UOP Platforming unit at Alma, Mich. provides high-octane components marketed as Leonard's "X-Tane" and "Super X-Tane" brands.

For more data on advertised products, use Readers' Service Cards, last page.



Ten ready answers for your corrosion problems come from the foundry ladle

Running white-hot from the foundry ladle is a proved corrosion fighter . . . a nickel-containing corrosion resistant alloy.

It doesn't matter what shapes are being poured in the molds shown above. Big, small or complex . . . casting is often the most economical, or the fastest, or the easiest way to obtain a corrosion resistant part. In some cases, casting is the *only* way to make the part.

It doesn't matter what corrosive service these parts are headed for . . . or what complicating factors will be encountered. The designer was able to choose from ten versatile, corrosion resistant alloys.

Look At The Properties You Can Get!

Besides corrosion resistance, you are offered strength, toughness, pressure-tightness, ease of cleaning.

Tensile strengths range from 70,000 to over 100,000 psi. Charpy impacts go up to 75 ft lbs., Brinell hardnesses up to 190, or more with proper heat treatment.

All the corrosion resistant castings have, as well, excellent heat transfer characteristics, excellent sub-zero properties, remarkable resistance to shock and vibration. All are weldable. All machinable.

ACI Designations

The table lists Alloy Casting Institute symbols for the nickel-alloy corrosion resisting castings, along with their nearest AISI wrought stainless steel counterparts.

ACI	AISI	ACI	AISI
CE-30	312	CF-8C	347
CF-8	304	CF-16F	303
CF-20	302	CH-20	309
CF-8M, CF-12M	316	CK-20	310
		CN-7M	—

Inco's new booklet "Heat Resistant Castings, Corrosion Resistant Castings . . . Their Properties and Applications" will be published soon. To get one of the first copies, simply write . . .

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Approved for many services including:

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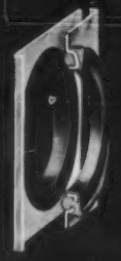
The Seats are the SECRET!



Line Pressure Seals the

The seats – made of specially formulated rubber molded to a hardened steel insert – are the secret to the valve's tight sealing performance. As line pressure in the valve increases, these unique seats actually float with the pressure to seal tightest where the most pressure is exerted.

Important Safety Feature

Excessive body pressure caused by thermal expansion is automatically relieved. The upstream seat is forced away from the gate by the excess pressure, allowing it to bleed into the line.

Change Seats in Minutes—on the line

You can change seats in W-K-M's Pressure Sealing Gate Valve (2" through 12") in 15 to 30 minutes . . . *on the line.* The only tools needed are a wrench and a pair of pliers.

Full Bore, Through-Conduit

Full bore, through-conduit gate construction permits a smooth flow with no more turbulence or pressure drop than through an equal length of pipe. The seats are fully protected from abrasive action of the lading flow.

Available Now

This versatile valve is available at leading supply stores everywhere. It's designed for pressures up to 720 psi (cwp) and temperatures up to 250° F.

ANOTHER OUTSTANDING PRODUCT OF W-K-M's *Creative Engineering*

Write for Catalog 1200

W-K-M

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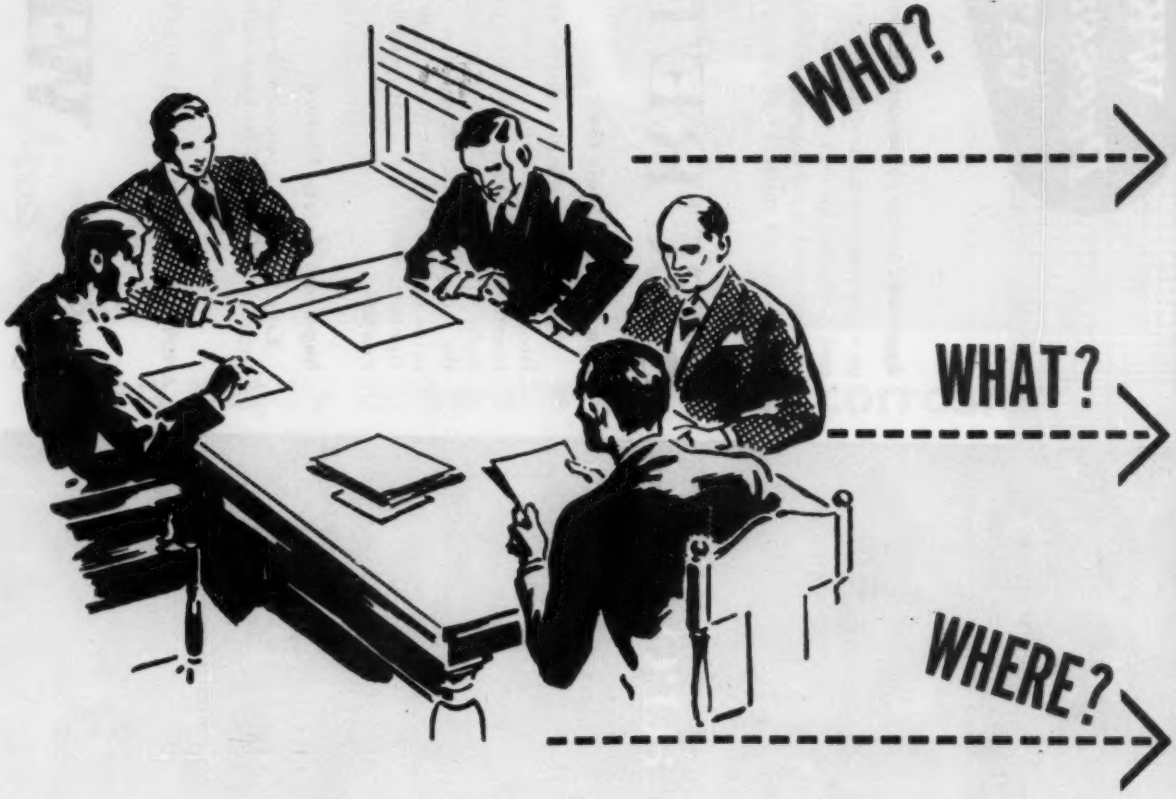
With Men



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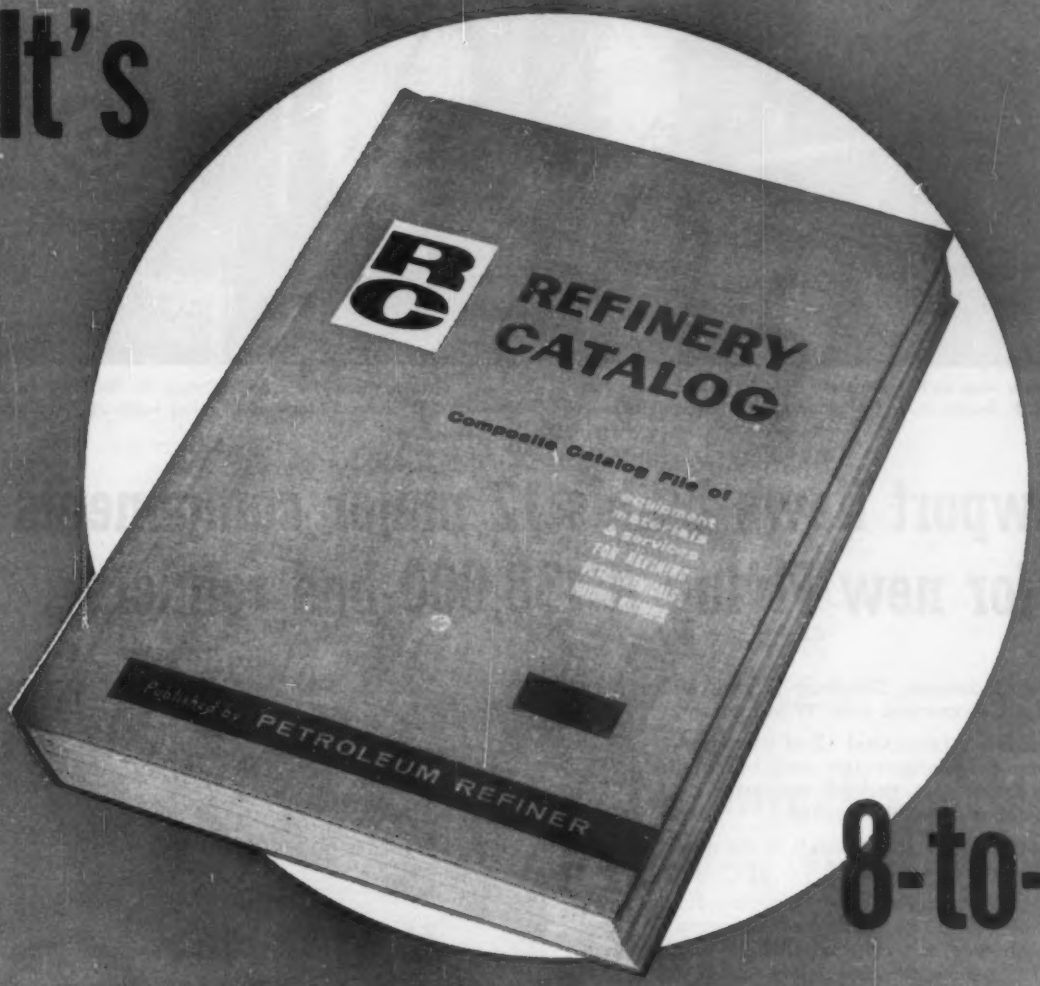
Who Buy And Specify

It's



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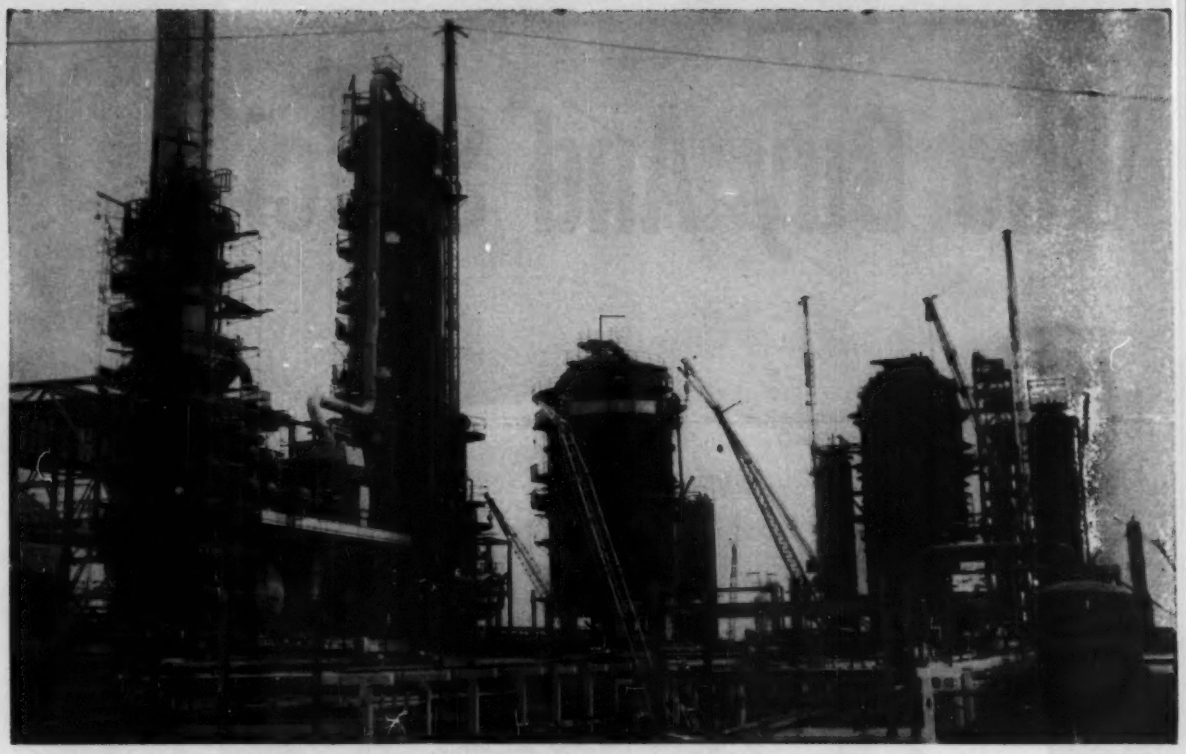

A dozen vessels built by Newport News were furnished under contract with C. F. Braun, Inc., of Alhambra, Calif., design engineers for the ultra-modern Delaware Flying A Refinery of the Tidewater Oil Company located 15 miles south of Wilmington.

Newport News builds 12 major components for new Flying A 130,000-bpd refinery

This is the Tidewater Delaware Flying A Refinery while under construction near Wilmington.

Newport News fabricated 12 of its major vessels — 2 of which are the largest such units ever built: a 250′ Orthoflow fluid "cat cracker" converter and a 225′ reactor scrubber of the fluid coker.

More notable than size, though, is the quality of the Newport News fabrication.

Coke-out screens in the reactor scrubber, for example, are made of 704 12% chromium segments. Welded together with accuracy, they provide 45% clear opening . . . with opening tolerances less than 1%.

You get expert fabrication, the skill of specialists when Newport News builds your equipment. When you want reactors, pressure vessels, vacuum tanks and the like, sub assemblies or weldments in almost any size or shape, get a bid from Newport News.

Send for newly published, easy-to-read, illustrated booklet, "Facilities and Products". It describes the many ways in which Newport News can help you with present or future projects. Write for your copy today.

Full advantage was taken of the Newport News deep water loading facilities for transportation of all of the equipment by barge. Shop erection prior to shipment assured fast, trouble-free field assembly.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia

Fast help on corrosion control
–A big Texas natural gas plant required periodic analyses to determine whether MEA solution was breaking down in regeneration, forming corrosive salts. Samples were being sent out of state for analysis, "took forever" to get results. Enter Allied. Now tests are run in Dallas, results come back *fast*, help this plant prevent corrosion before it can start.

New plant start-up trouble quickly traced–Slug of distillate filled inlet scrubber, carried over to amine system. Aqueous amine solution thoroughly contaminated with hydrocarbon. Customer shut down plant, was going to dump entire charge. Allied specialists diagnosed trouble as too rich amine concentration, then suggested decanting solution into empty tanks, which saved half of charge.

Foaming in glycol plant–Customer wanted to know what caused it, how to stop it. Allied specialists flew to the site, deduced cause of the trouble in a matter of hours. Lab analysis confirmed their findings. In a recommendation just five typewritten lines long, they told customer how to solve the problem completely, economically.

USE GLYCOLS OR AMINES?

ALLIED technical service is ready–right now–to help you find straight answers to knotty problems

BASIC TO AMERICA'S PROGRESS

Allied Chemical

NITROGEN DIVISION
Dept. GA-5-21-3, 40 Rector Street, New York 6, N. Y.

2819

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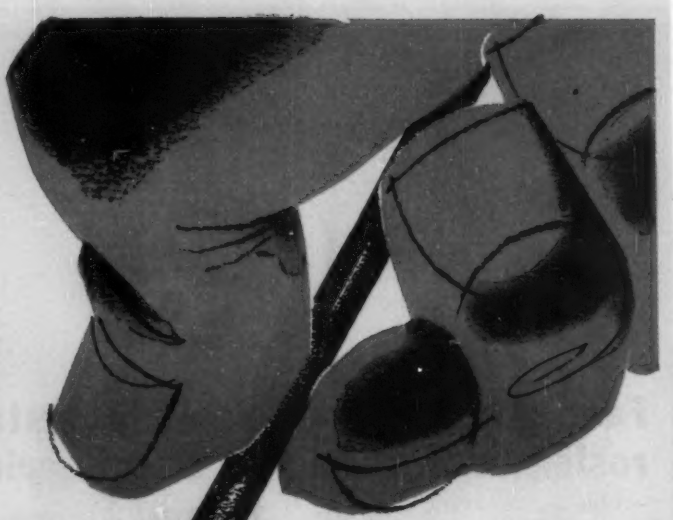
IF YOU USE VALVES



YOU NEED THIS CATALOG!

Kerotest has been producing highest quality valves for the past 50 years for customers all over the world. Our new catalog—just off the press—gives dimensions, specifications and working tables to help you specify the right valves for refinery, industrial and marine applications.

Send for your copy—today!

KEROTEST

KEROTEST MANUFACTURING COMPANY
2514 LIBERTY AVENUE · PITTSBURGH 22, PA.

Texaco's Stowell Field, Winnie, Texas—Foxboro Type 37 Dry Meters used on billing service.

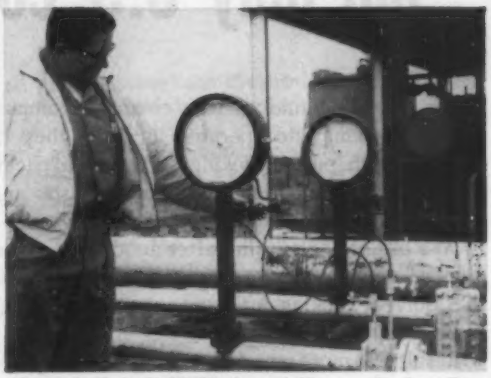
Foxboro "Dry" Meters eliminate costly mercury maintenance, damage from overrange

There are over 50 Foxboro T/37 "Dry" Flow Meters in Texaco's East Texas gas fields. Some measure flare gas and gas flow to compressors while others handle billing assignments.

Foxboro "Dry" Meters give users two distinct benefits. First—since there is no mercury to clean, or replace, they're cheaper to maintain. Second—since the T/37's unique diaphragm assembly can't be damaged by overrange, line surges and winter freeze-ups cease to be a problem.

As for accuracy—monthly checks have found only two of the 50 meters that ever needed recalibration.

Producers, pipeliners, plant men—they're all reporting superior flow metering with Foxboro Dry Flow Meters. Get full details from your nearby Foxboro Field Engineer. Or write for Bulletin 7-15. The Foxboro Company, 7412 Neponset Avenue, Foxboro, Massachusetts.



Texaco's Cody Field, Clarkwood, Texas—Foxboro Dry Meters measuring flare gas, and gas flow to compressor.

FOXBORO
REG. U.S. PAT. OFF.

For more data on advertised products, use Readers' Service Cards, last page.

SOLVENT PACKINGS

"We tested one packing after another... but only 'U.S.' could stand up,"

Says CHEMICAL PLANT SUPERINTENDENT

When a leading mid-western chemical company put their new plant into operation in 1955, they faced a problem with pump packings: To find a packing resistant to a combination of solvents, caustic and high temperature—with a minimum of shaft wear.

"We tested one packing after another on our caustic pumps," says the plant superintendent, "and found that U. S. Solvent Packing outlasted any other packing tested *by as much as 10 to 1.*"

Result: No more morale-breaking "clean-up" sessions, production is increased, personal injuries due to leaks have been reduced 75%, and there's no need for rescheduling due to breakdowns.

A "U. S." technician, of course, worked with engineers of the chemical company to develop the right packing for this particular requirement. That's part of the "U. S." service, when needed.

• • •

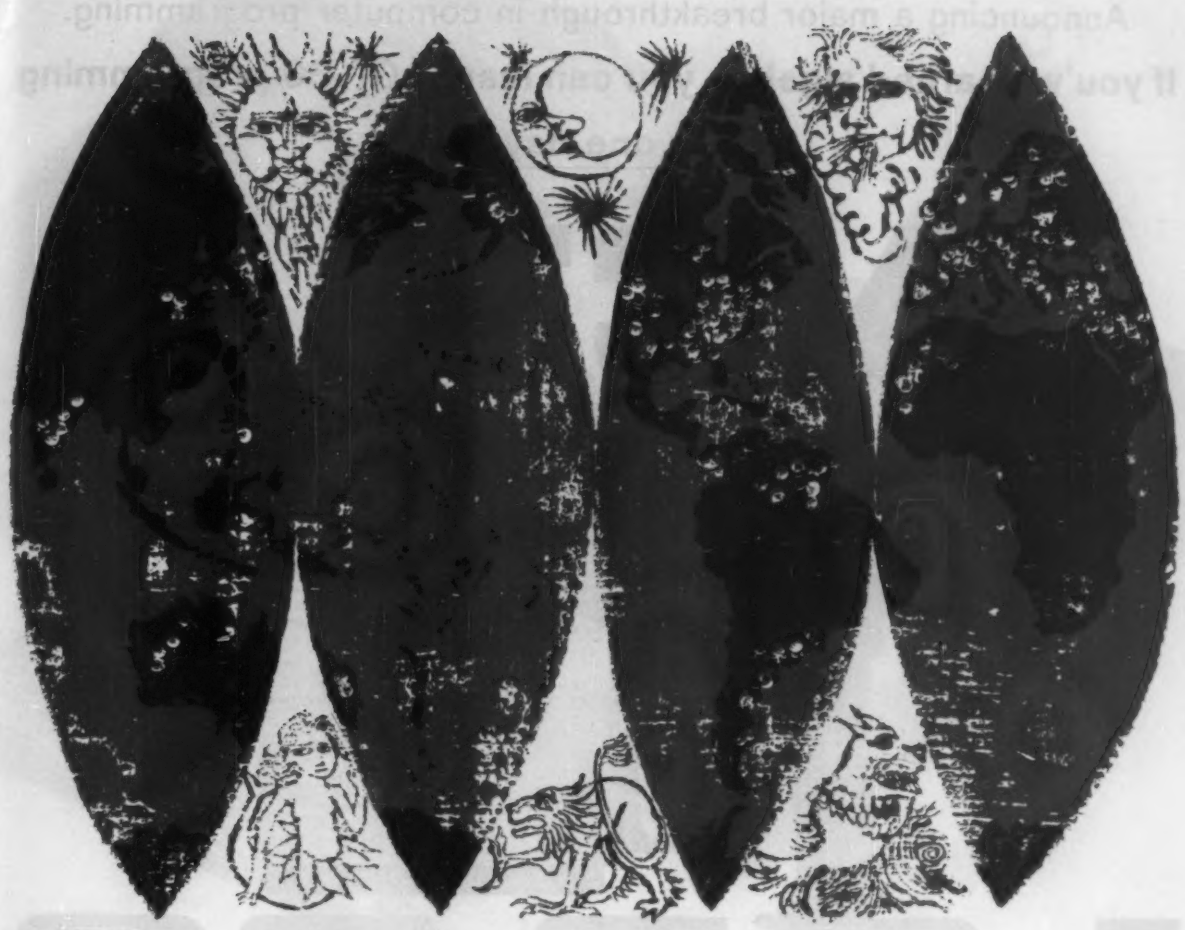
When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.



805 reasons a Foster Wheeler plant fits your requirements best

Wouldn't you like to find your new plant running on its scheduled completion date, meeting all specifications, and at a cost within the construction budget? The process industries have come to expect results like these when dealing with Foster Wheeler.

Would you like to see your own process plants handled by designers, engineers and construction men who have successfully put 75 different processes into efficient commercial operation?

And, if you have decided to pioneer a new process, wouldn't you like to have the advantage of Foster Wheeler's long experience with basic processing methods, such as fluidized solids, effluent refrigeration, simplified sulfonation, and efficient heat balancing in chemical operations, etc. This unique experience—plus *procurement knowledge* gained in construction of some 805 large and small plants throughout the world, and *specialized equipment know-how* available through FW's own equipment division—works for you when you use FW design, engineering and construction services.

Get specific information by discussing your process needs and plant requirements with Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.—or write for a copy of the new fully-illustrated booklet describing FW's services.

Heat Engineered products, plants and processes...for the world's industrial progress.

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

petroleum processing

chemical processing

specialized installations

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Announcing a major breakthrough in computer programming.

If you've learned algebra, you can learn LGP-30 programming in just one day with

ACT 1

Algebraic Compiler and Translator

LGP-30

Electronic Digital Computer

The simplest, most economical compiling routine yet developed, ACT 1 now joins with the powerful Royal Precision LGP-30 to give you an unbeatable combination – low-cost, versatile general purpose electronic computation *and* programming.

With only a basic knowledge of mathematics, you can teach yourself ACT 1 in a single day. You can then submit any problem to the computer in simple algebraic form.

ACT 1 translates from a language you know into the machine language of the LGP-30. ACT 1 need not remain in the LGP-30 at compute time–giving you the entire computer memory (4096 words) for useful calculation. Both compiling and computing times are very rapid. Because the machine language program is punched on tape, it can be automatically brought into the computer whenever required.

Capable of compiling a fixed and/or floating point program for the LGP-30, ACT 1 vastly reduces programming time, gives you final solutions *faster than ever!* It is by all odds the simplest compiler to learn *and* to use.

We will be happy to send you the ACT 1 compiling routine free of charge. Write today to Royal McBee Corporation, Data Processing Division, Port Chester, New York.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. LGP-30 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For complete information on the LGP-30 write **ROYAL McBEE CORPORATION,** data processing division, Port Chester, New York

Meeting of minds and methods

THE specialized talents of McKee engineers and the experienced skills of McKee construction experts meet on plant projects like yours all over the world. It is this meeting of imaginative engineering minds and modern construction methods that assures you correct design and sound construction of your plant.

The McKee insignia is a familiar sight to petroleum and chemical men in thirty-six countries. They're familiar with McKee results, too—that's why more than eighty percent of our work is repeat business from satisfied customers.

If you are planning new processing facilities or related projects, large or small, in any location, we would welcome an opportunity to show you the many advantages of McKee services.

ARTHUR G. McKEE & COMPANY • 2300 Chester Avenue • Cleveland 1, Ohio

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McKEE ENGINEERING AND CONSTRUCTION SERVICES

Nationwide stocks give you prompt delivery...

on CF&I-CLAYMONT HEADS

This giant steelman – the Image of CF&I – represents *service* for CF&I customers coast to coast. One example of this service is the inventory of Claymont Steel Head stocks maintained at strategically-located CF&I warehouses.

Elliptical Heads are stocked at Houston • Los Angeles • San Leandro, Calif. • Tulsa

Inside Diameters–24" to 120"
Specifications–A-285-C and A-212-B Firebox Steels

ASME and Standard Flanged and Dished Heads are stocked at Chicago • Claymont, Del. • Houston • Tulsa

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Specifications – ASTM A-285-C Flange and Firebox Steel; Hot Pressing Steel (for Standard Heads only)

Fittings are stocked at Chicago • Claymont, Del. • Houston • Tulsa

Manhole and Handhole Fittings • Elliptical Manhole Rings for Low Pressure Vessels • Storage Tank Manhole Frames and Covers

Claymont is completely equipped to produce spun or pressed heads in diameters from 9" to 19'...in gages from 3/16" to 6"...in all shapes and a complete range of ferrous and non-ferrous metals.

Complete details on Claymont Head stocks are published and distributed monthly. If you are not now receiving this stock list, and would like to, just notify the CF&I sales office nearest you.

CF&I-CLAYMONT PRODUCTS: Carbon Steel Plates • Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Pressed Steel Shapes • Manhole Fittings, Covers and Saddles • Fabricated Steel Plate Products • Large Diameter API Pipe

Claymont Steel Products

THE COLORADO FUEL AND IRON CORPORATION

CF&I STEEL

In the West: **THE COLORADO FUEL AND IRON CORPORATION**—Albuquerque • Amarillo • Billings • Boise • Butte • Denver • El Paso • Farmington (N. M.) • Ft. Worth • Houston • Kansas City Lincoln • Los Angeles • Oakland • Odessa • Oklahoma City • Phoenix • Portland (Ore.) • Pueblo • Salt Lake City • San Francisco • San Leandro • Seattle • Spokane • Tulsa • Wichita
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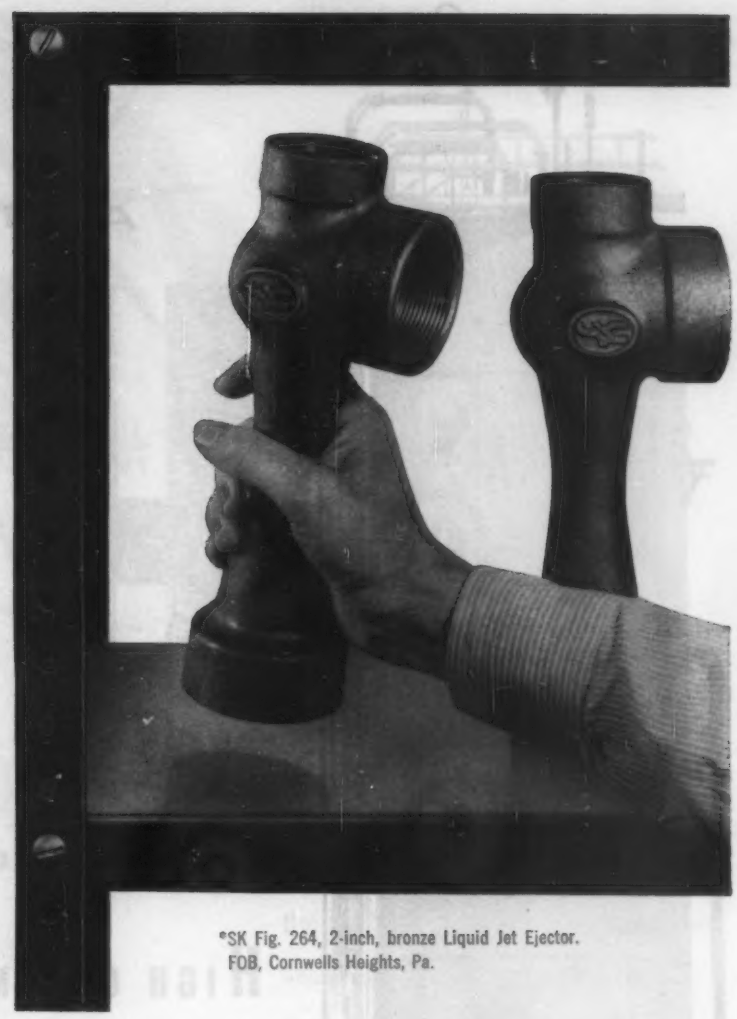
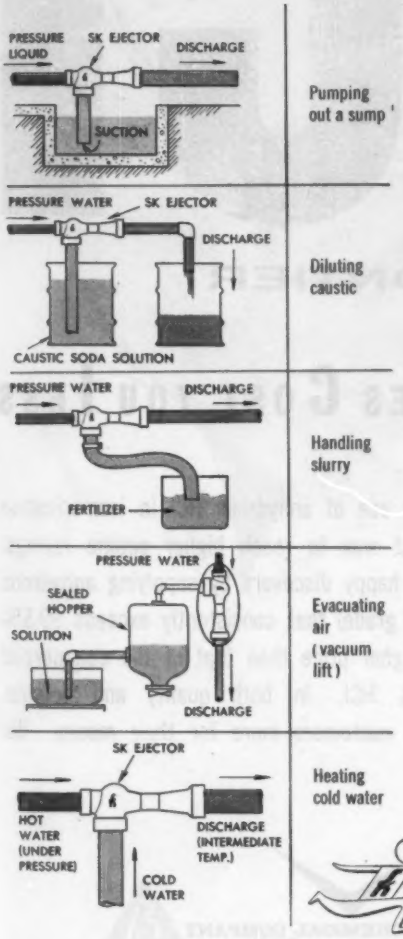
FOR $50.60 EACH* YOU CAN STOCK EJECTORS THAT WILL PUMP, MIX, EVACUATE, AGITATE



*SK Fig. 264, 2-inch, bronze Liquid Jet Ejector. FOB, Cornwells Heights, Pa.



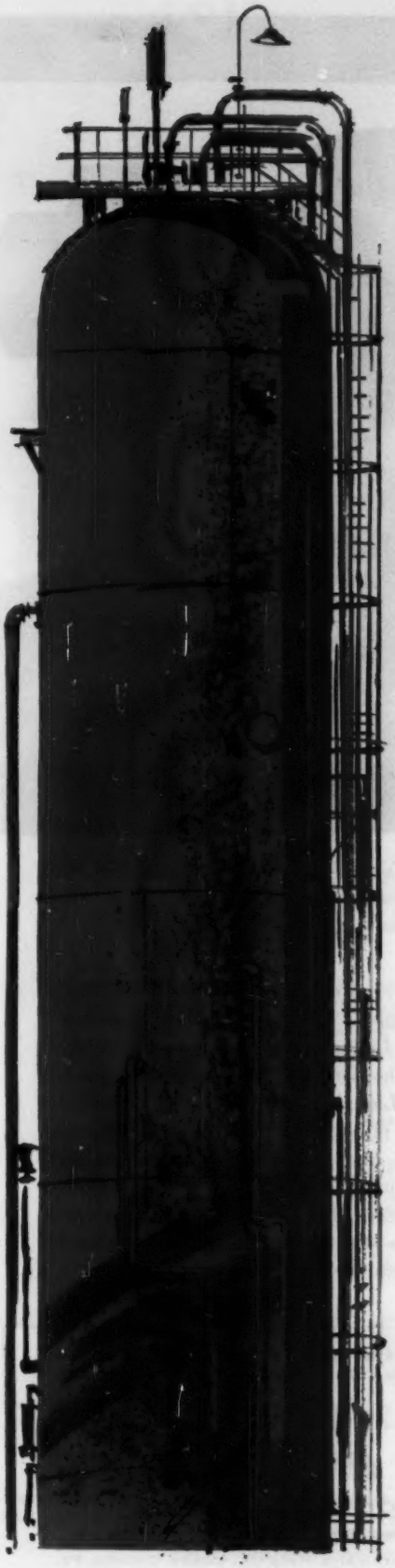
Want to pump out a sump . . . mix two liquids, or a liquid and a solid . . . handle a slurry . . . prime a pump . . . agitate a solution? Low cost, uncomplicated SK Liquid Jet Ejectors are ideal for *any* of these jobs. That's why thousands of companies (like yours) keep several *always* in stock. Liquid Jet Ejectors utilize the kinetic energy of a pressure liquid to pump, mix and agitate other liquids, handle slurries and fine solids, and evacuate air. They are stocked in cast iron, bronze, 316 stainless steel, PVC, Haveg, and PYREX brand tubing, for quick delivery. The sketches will give you a few ideas on how you might use a stock ejector. For complete details on types, sizes, capacities, write for Bulletin 2M.

For immediate delivery, standard SK Jet Ejectors, Rotameters, and Flow Indicators are stocked in Cornwells Heights (Phila.), Pa., Houston, Texas, and San Francisco, Calif.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Condensed Bulletin G-1.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2257 State Road, Cornwells Heights, Bucks County, Pa.

For more data on advertised products, use Readers' Service Cards, last page.



ANHYDROUS

HCl

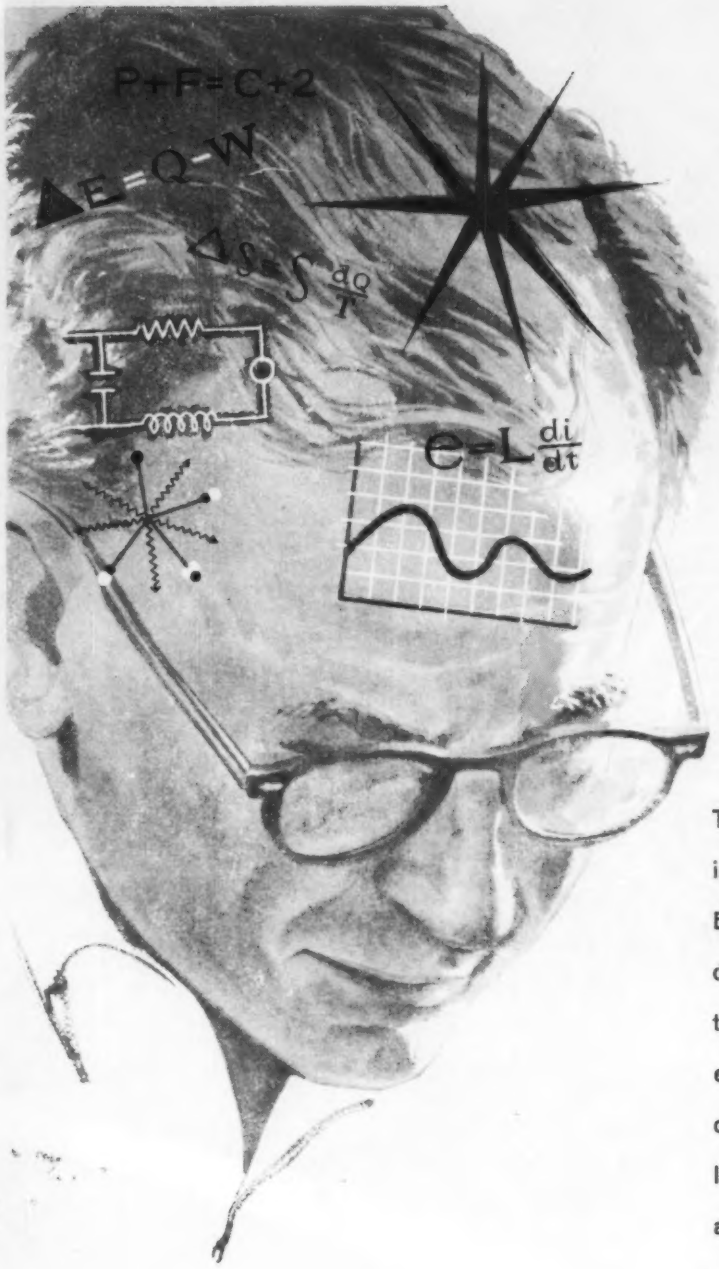
FRONTIER

HIGH OCTANES COST YOU LESS

Many refiners find that the use of anhydrous HCl in isomerization processes offers a low cost way to reach higher octane ratings. Frontier contributes to this happy discovery by supplying anhydrous hydrogen chloride (technical grade) that consistently exceeds 99.5% concentration . . . at no higher price than that of the commercial standard 97.5% to 99.0% HCl. In both quality and service, Frontier strives to give its customers more for their money. We shall welcome your inquiry.

FRONTIER CHEMICAL COMPANY

division VULCAN MATERIALS COMPANY *Wichita*



Instruments of the Mind

The engineer has his specialized instruments, as does the surgeon. But the work these instruments perform depends upon the thought that guides them. Knowledge and judgment are essential to any project, but superiority comes only from originality... ideas. If there is a new and better way, engineers at Brown & Root will find it. Practical results in greater efficiency at lower costs have built a world-wide reputation for engineering by Brown & Root.

BROWN & ROOT, INC.

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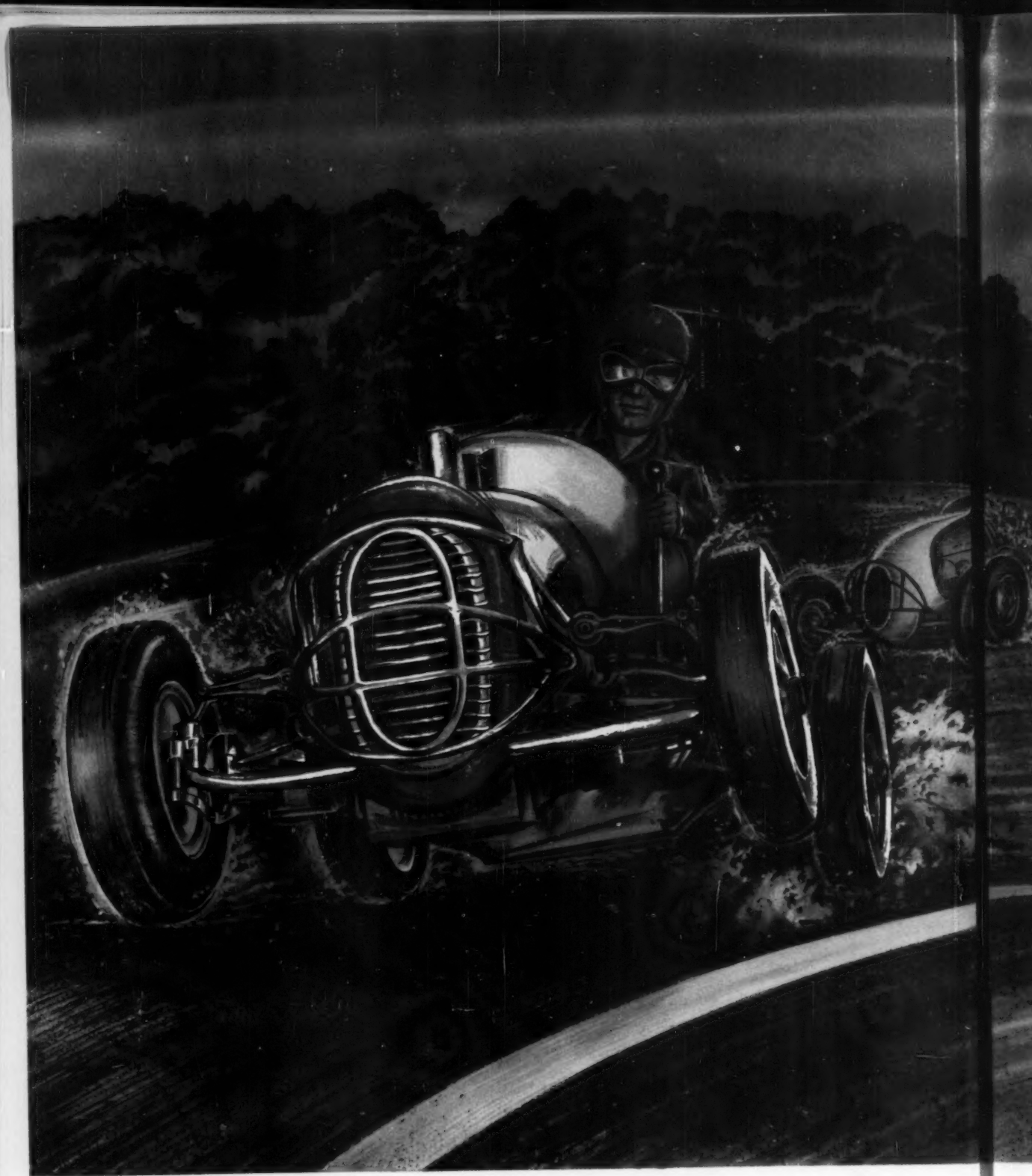


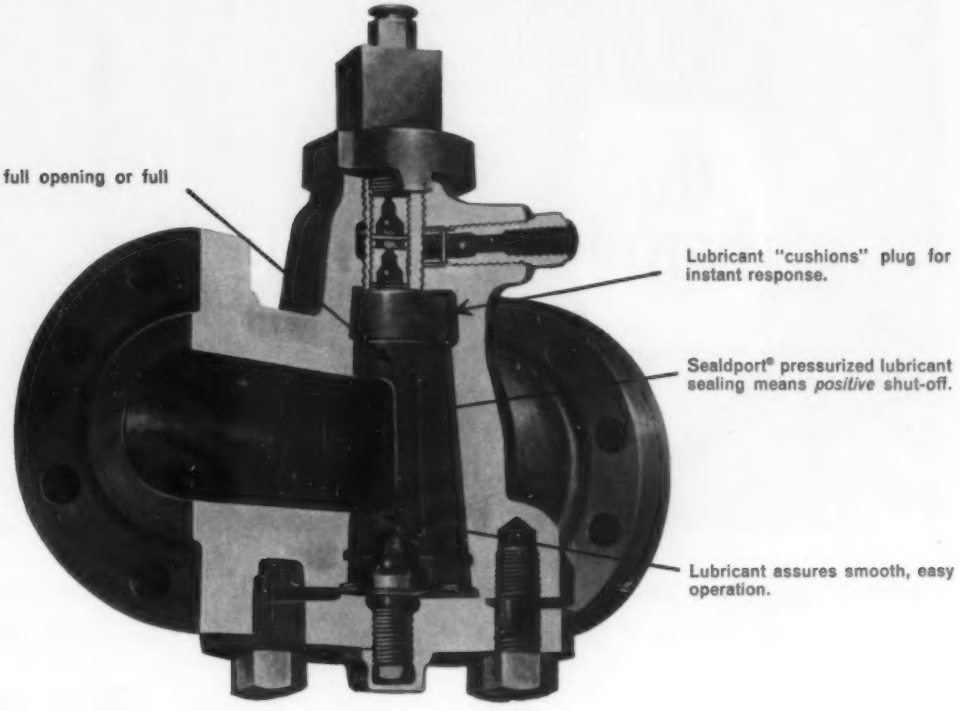
ROCKWELL- Nordstrom **VALVES**

Where control is vital

It isn't just speed and power that wins races . . . it's *control* that makes consistent winners.

It's the same with valves. Valves that are awkward or slow to operate may "lose the race" against impending disaster or costly flow control errors. That's why, wherever flow control must be instantly responsive, you'll see Rockwell-Nordstrom lubricated plug valves. Their *quarter-turn* lubricated closure means perfect control *every time.* The drawing below shows why these valves are so often demanded for the flow control jobs where errors can't be tolerated . . . and why they make flow control foolproof on every service.

PERFECT, FOOLPROOF VALVE OPERATION


¼ turn for full opening or full closure.
Lubricant "cushions" plug for instant response.
Sealdport® pressurized lubricant sealing means *positive* shut-off.
Lubricant assures smooth, easy operation.

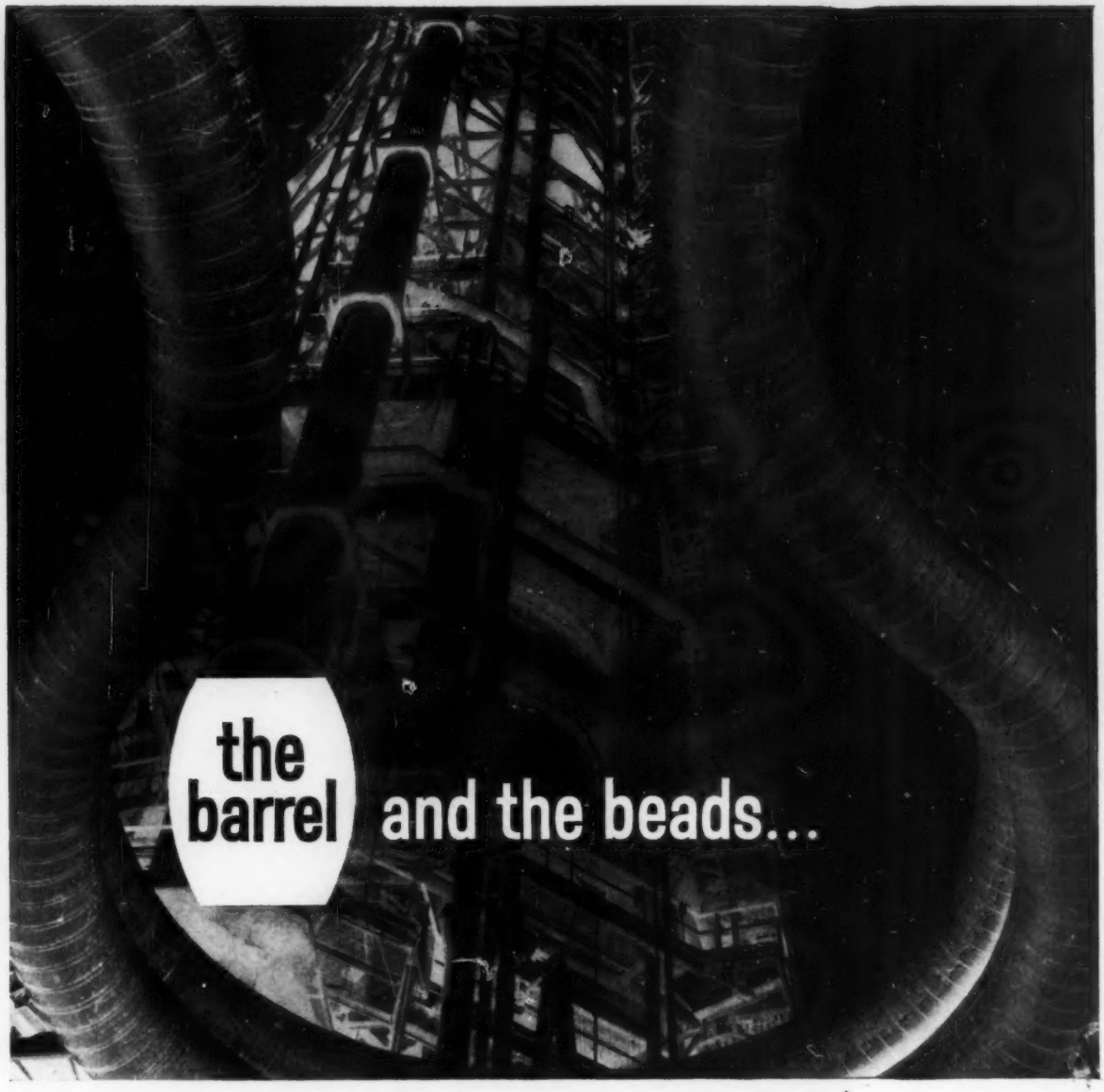
Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from ¾" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

®Reg. T.M. Rockwell Manufacturing Company

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL



How to get more yield from a barrel of crude for less cost—the new bead catalyst that makes it possible—what it means to the petroleum industry

Petroleum refiners around the world have always had one common economic objective—to get more yield from every barrel of crude oil at lower cost.

Socony Mobil's contributions toward this goal have been outstanding. From the development of the first Thermofor Catalytic Cracking unit and its successor, the Airlift TCC, to the introduction of Durabead, the most efficient, cost-cutting bead catalyst today, Mobil Catalyst Research has led the way in pushing yield levels ever higher, yield costs ever lower.

Now Mobil takes the lead again with Heavy Durabead, a new bead catalyst with all the features of Durabead, plus important new advantages. Heavy Durabead can cut TCC unit construction costs as much as 20%. Used in present TCC units, it can increase reactor and regenerator capacities up to 50%, compared to chrome bead catalyst.

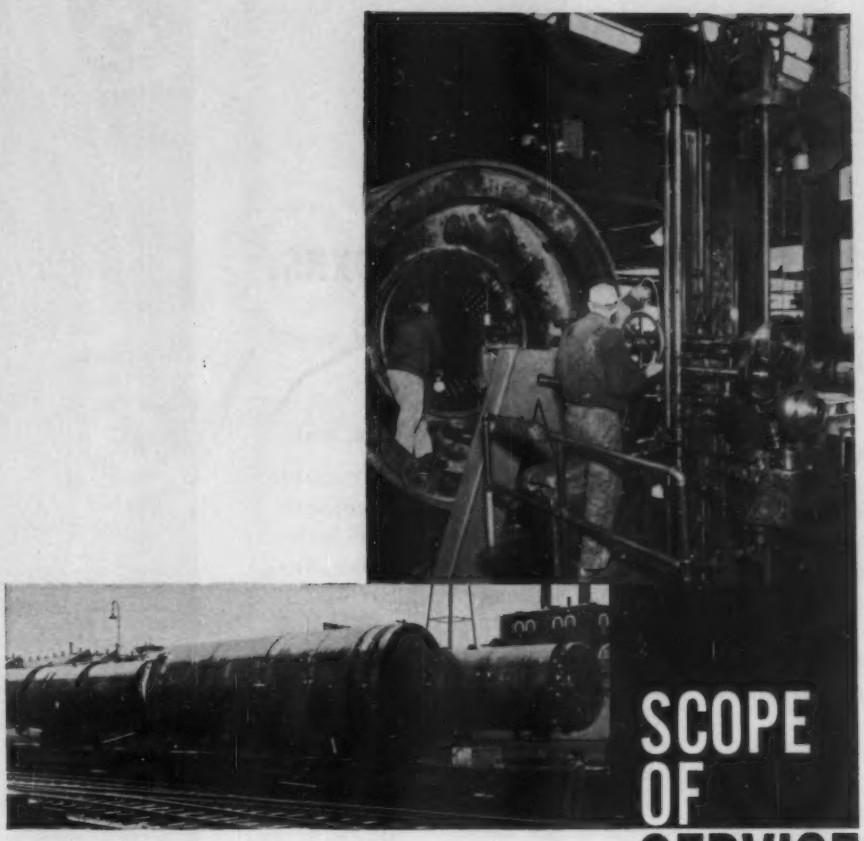
* * *

These are the results of Mobil Catalyst leadership—*greater yields of salable products from every crude oil barrel, increased profits for TCC licensees and operators of other moving bed units in the petroleum industry.*

Socony Mobil Oil Company

Leader in catalyst research

Mobil



SCOPE OF SERVICE

For 43 years the facilities of this large and well-equipped plant for ship and engine building have been employed in building special equipment for oil refineries and chemical plants.

This equipment varies from small tanks to large Fractionating Towers, Stills, Pressure Vessels, Special Machinery, Plate Work, etc. Carbon or alloy steel-annealed and X-rayed.

THE PLANT—Our plant consists of such a variety of shops and machinery that it is unnecessary to sublet when building the type of equipment here listed. The plant consists of:

Boiler and Tank Shops

Steel Fabricating Shops	Machine Shops
Blacksmith Shop	Pipe Shop
Anglesmith Shop	Electric Welding
Coppersmith Shop	Stainless Shop

RAIL OR WATER SHIPMENT—Our plant, located on the Delaware River with piers and deep water to care for sea-going ships, has railroad connections to all points.

We have adequate facilities to handle our work in all its phases and do not have to sublet.

Further information, estimates or proposals on request.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • SINCE 1916 • CHESTER, PA.

For more data on advertised products, use Readers' Service Cards, last page.

Sure Source of top-quality plate work . . .

American Bridge at Orange, Texas.

If your business requires equipment made from steel plate—heavy-wall pressure vessels, tanks, stacks, bins, pipe, etc.—American Bridge invites your attention to its recently modernized plate fabricating facilities at Orange, Texas.

The plant itself, one of the largest in the country, is a huge two-aisle building, 177′ wide and 750′ long, with crane runways extending 270′ and 200′ at either end. Equipment includes seven cranes capable of lifting, in combined use, over 100 tons.

Fabricating facilities include large car bottom-heating and stress-relieving furnaces, heavy-plate bending rolls, a variety of presses and press brakes, the latest in welding and X-raying equipment, plate shears, edge planers, boring mills and drills.

These facilities enable American Bridge to handle practically any plate job regardless of size. And great capacity permits the handling of several large jobs simultaneously.

Efficient and economical construction service, too!

American Bridge has the most complete range of construction equipment in the industry, plus skilled personnel backed by over fifty years of experience. *Anything we fabricate, we can erect.*

And, because of the strategic location of our Orange plant on water, rail and truck routes, you can count on fast delivery and low shipping costs.

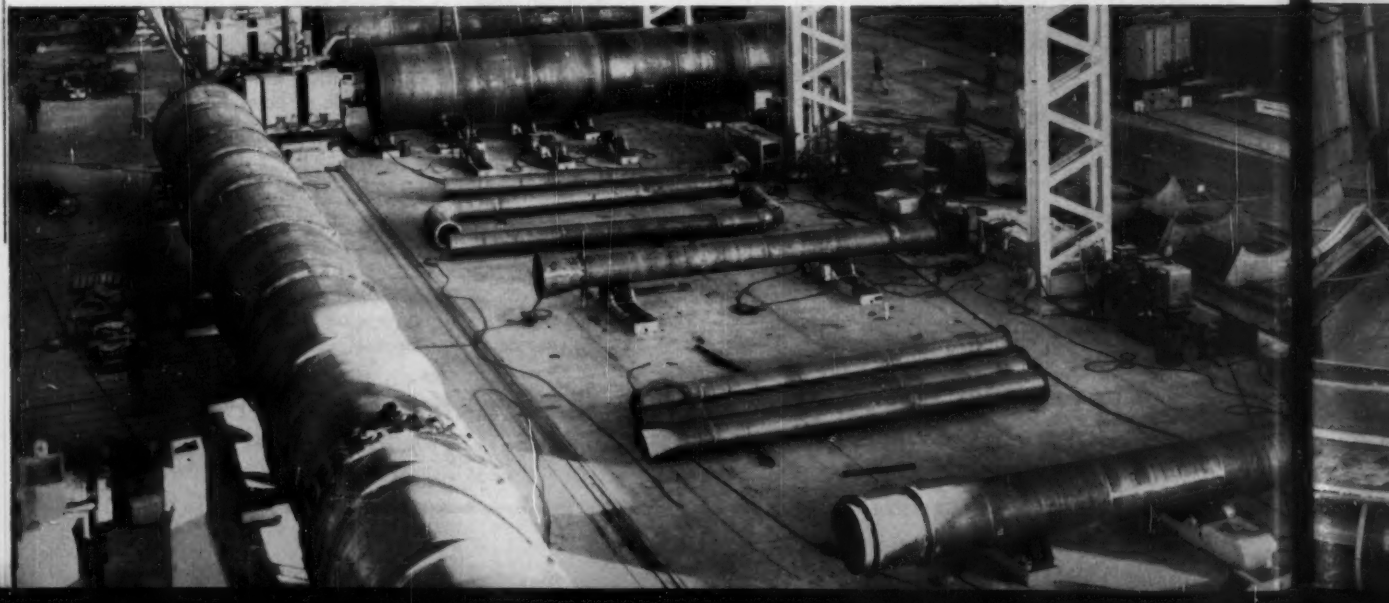
For top-quality plate work, contact any of the offices listed below. Or write for our booklet which describes the facilities and services available from our Orange plant.

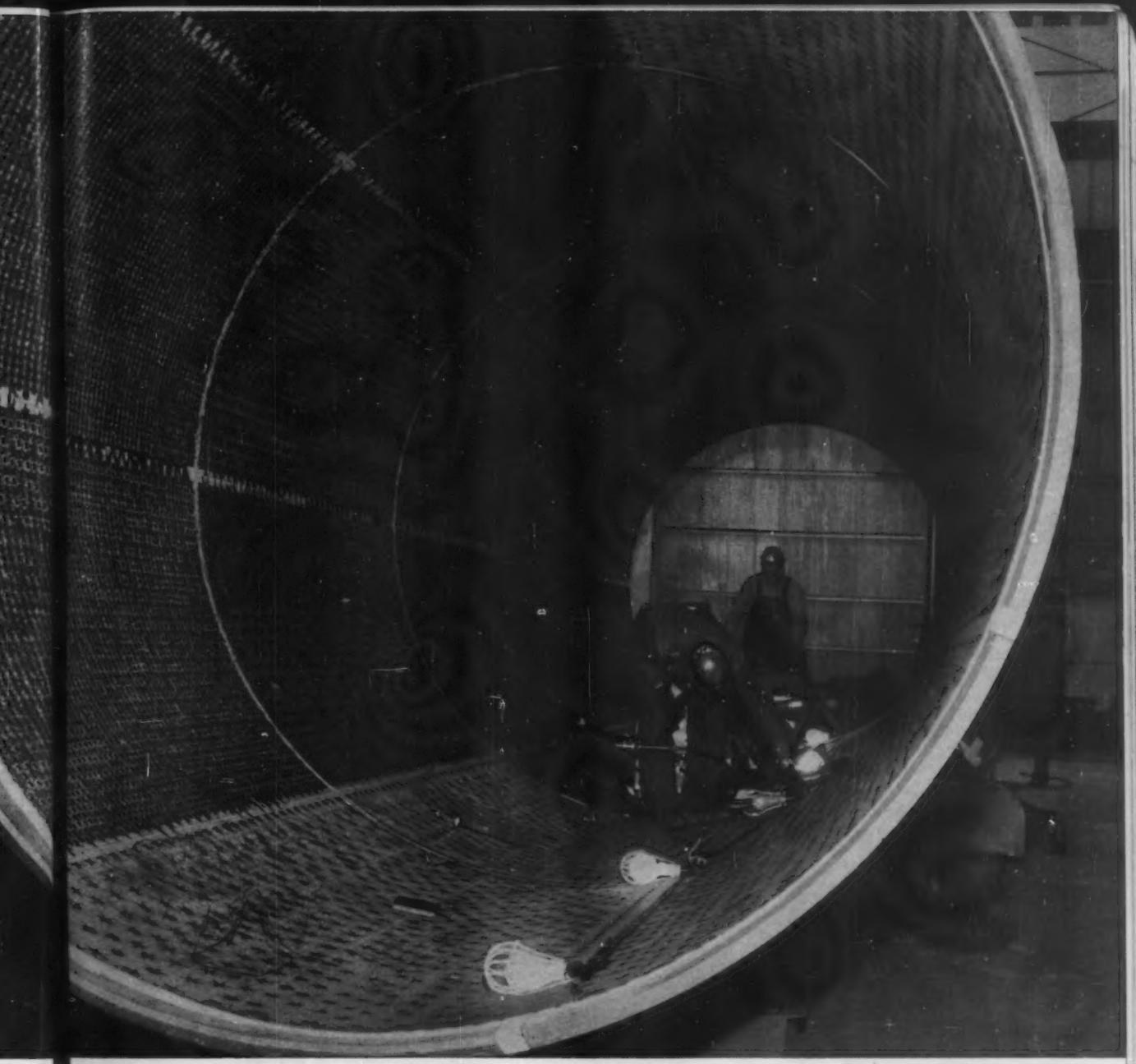
USS is a registered trademark

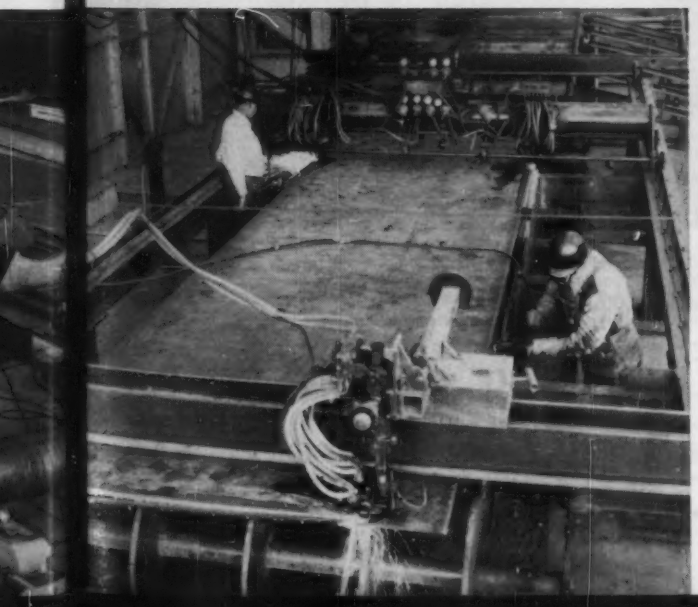
American Bridge Division of United States Steel

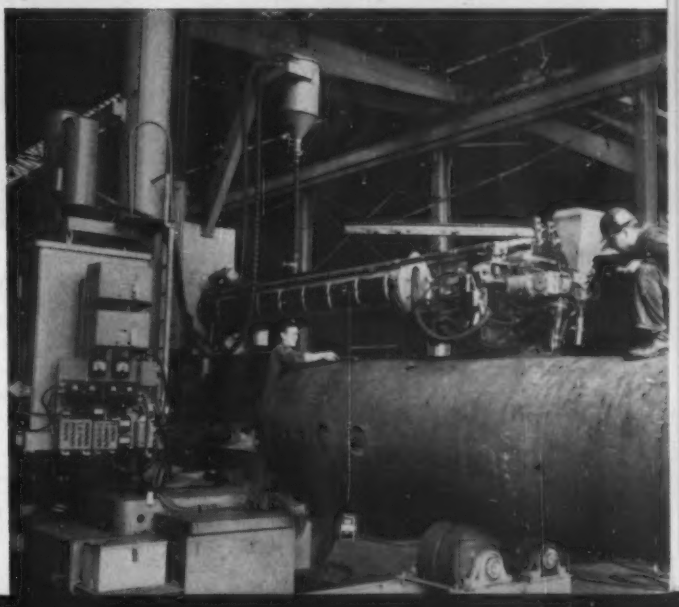
Genera Offices: 525 William Penn Place, Pittsburgh, Pa.

Contracting Offices: Ambridge • Atlanta • Baltimore • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Dallas • Denver Detroit • Elmira • Gary • Harrisburg, Pa. • Houston • Los Angeles • Memphis • Minneapolis • New York • Orange, Texas • Philadelphia Pittsburgh • Portland, Ore. • Roanoke • St. Louis • San Francisco • Trenton • United States Steel Export Company, New York









FOAMGLAS® insulation on these methyl ethyl ketone filters cuts insulation maintenance costs

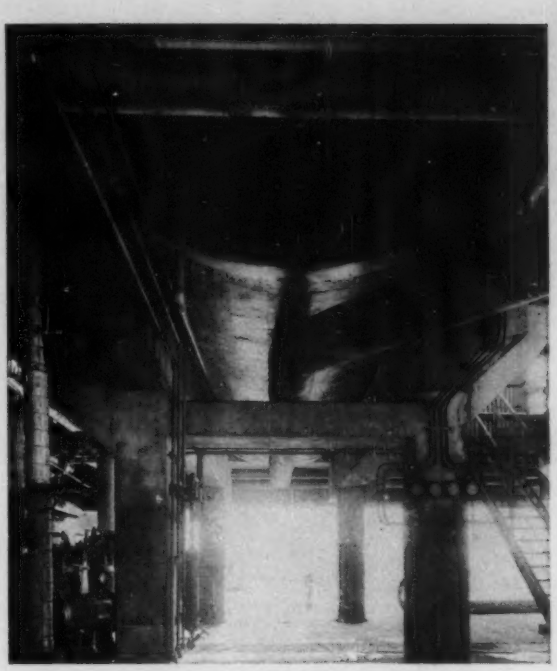
A saving in ketone filter insulation maintenance at the Beaumont, Texas, refinery of Mobil Oil Co. is made possible by the many features of FOAMGLAS insulation.

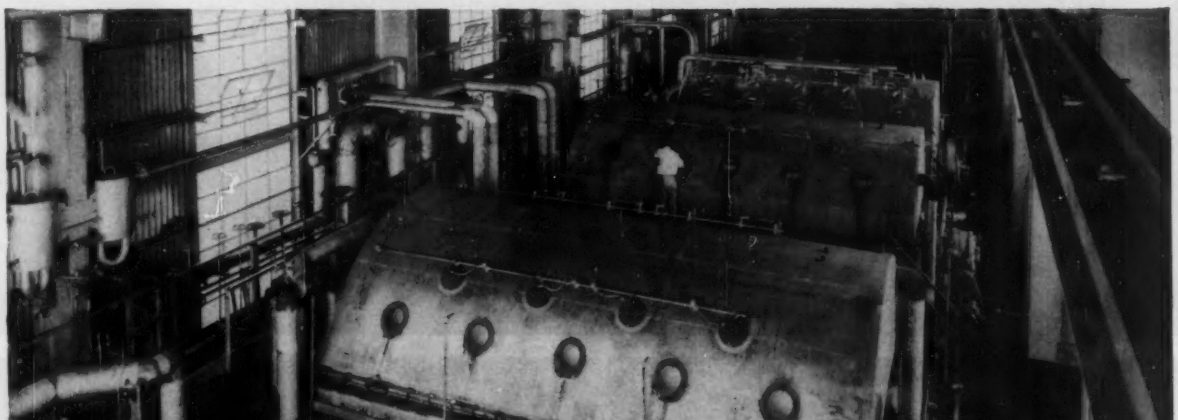
Different operating temperatures for different jobs subject this insulation to constant strain. Filters are chilled anywhere from 40°F. to 0°F., often resulting in ice formation from condensed water vapor. This has damaged insulation materials previously used. But water vapor cannot penetrate the sealed glass cells of FOAMGLAS. There's no crushing "freeze-thaw" cycle within the FOAMGLAS as there is with organic insulations.

Insulation loses much of its effectiveness when it is waterlogged. Not FOAMGLAS, however. Other insulations tried had required frequent maintenance, while FOAMGLAS remains effective for the six years it has been in use. Extremely easy to work with, easy to cut and shape with any sharp tool, FOAMGLAS is impervious to acid . . . even ketone.

Why not find out more about FOAMGLAS insulation? Write for a sample and for information on our two newest products; FOAMGLAS Stay-Dry Pipe Insulation, and new 1¾" FOAMGLAS Roof Insulation. Pittsburgh Corning Corporation, Department Z-129, One Gateway Center, Pittsburgh 22, Pennsylvania. In Canada: 3333 Cavendish Boulevard, Montreal, Quebec.

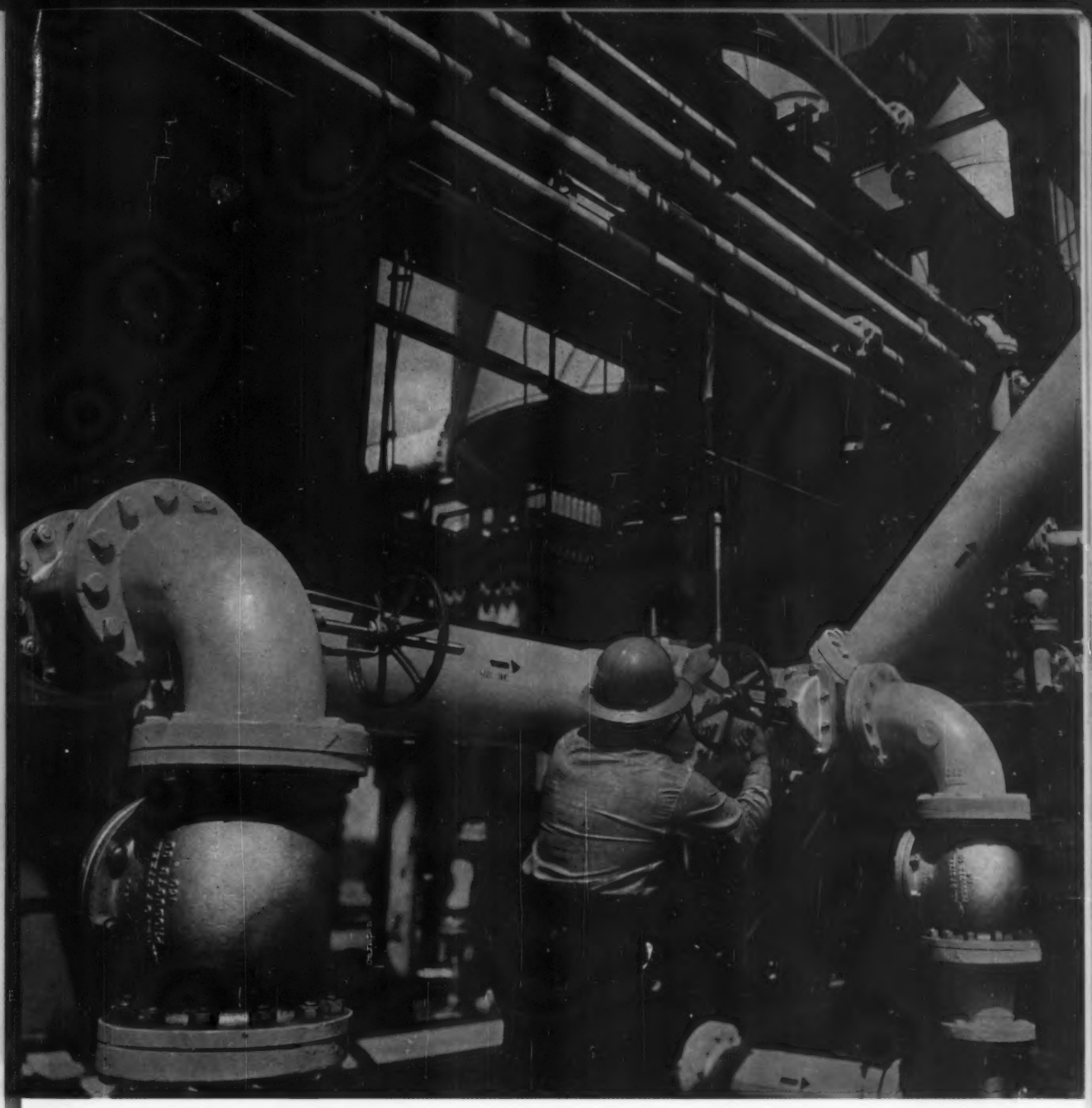
Pittsburgh Corning offers a complete line of mastics, tank coatings and other accessory materials specifically designed for use with FOAMGLAS.





The three filters shown above are typical of filters insulated with FOAMGLAS. These 21' by 11' diameter filters, insulated with layers of 2" and 3" FOAMGLAS, separate wax from oil. The refinery, largest in the Mobil system, has a rated capacity of 220,000 barrels per day.

PITTSBURGH PC CORNING



Aloyco Valves in General Chemical's new "dream" plant

The Aloyco Valves you see here are controlling the flow of 98% acid in the new sulfuric acid plant of General Chemical Division, Allied Chemical Corporation, at Elizabeth, New Jersey.

The plant utilizes most modern processing techniques. All equipment was chosen for its special ability to contribute to operating efficiency and long life.

For example, valves made in Aloyco 20, an alloy exceptionally resistant to corrosion from sulfuric acid, were specified for handling spent and sludge acids, as well as finished strong acid and oleum.

When you are selecting valves for corrosive service, remember only Alloy Steel Products Co. specializes in Stainless Steel Valves exclusively. Call our local representative or write us at 1301 West Elizabeth Avenue, Linden, N. J. 9.2

ALLOY STEEL PRODUCTS COMPANY

Boston · New York · Wilmington · Atlanta · Buffalo · Pittsburgh · Chicago · St. Louis · San Francisco · Los Angeles

"No fundamental changes have occurred in the underlying forces which have made the oil industry a good bet for the long pull. Increased populations, increasing living standards, increased industrialization will make it necessary for the free world industry to provide in 1975 something in the order of 14,000,000 barrels a day more oil than were consumed in 1958. This means that by 1975 world oil demand will have increased by about thirteen times Saudi Arabia's current output." – M. J. Rathbone, President

Standard Oil Company (New Jersey)

and affiliated companies

If you have the problem of increasing octane rating and production in your existing equipment, investigate the unique performance of Sinclair-Baker RD 150 Platinum Reforming Catalyst. Its efficiency in producing *important yield increases at high octane levels* is a matter of record. The long period of RD 150 operation is unmatched by any other catalyst . . . further, *it is regenerative in situ!* Cost is sharply reduced to lowest level.

Higher octane levels and longer catalyst life... with existing equipment ...merely by replacing with Sinclair-Baker RD 150 Platinum Catalyst

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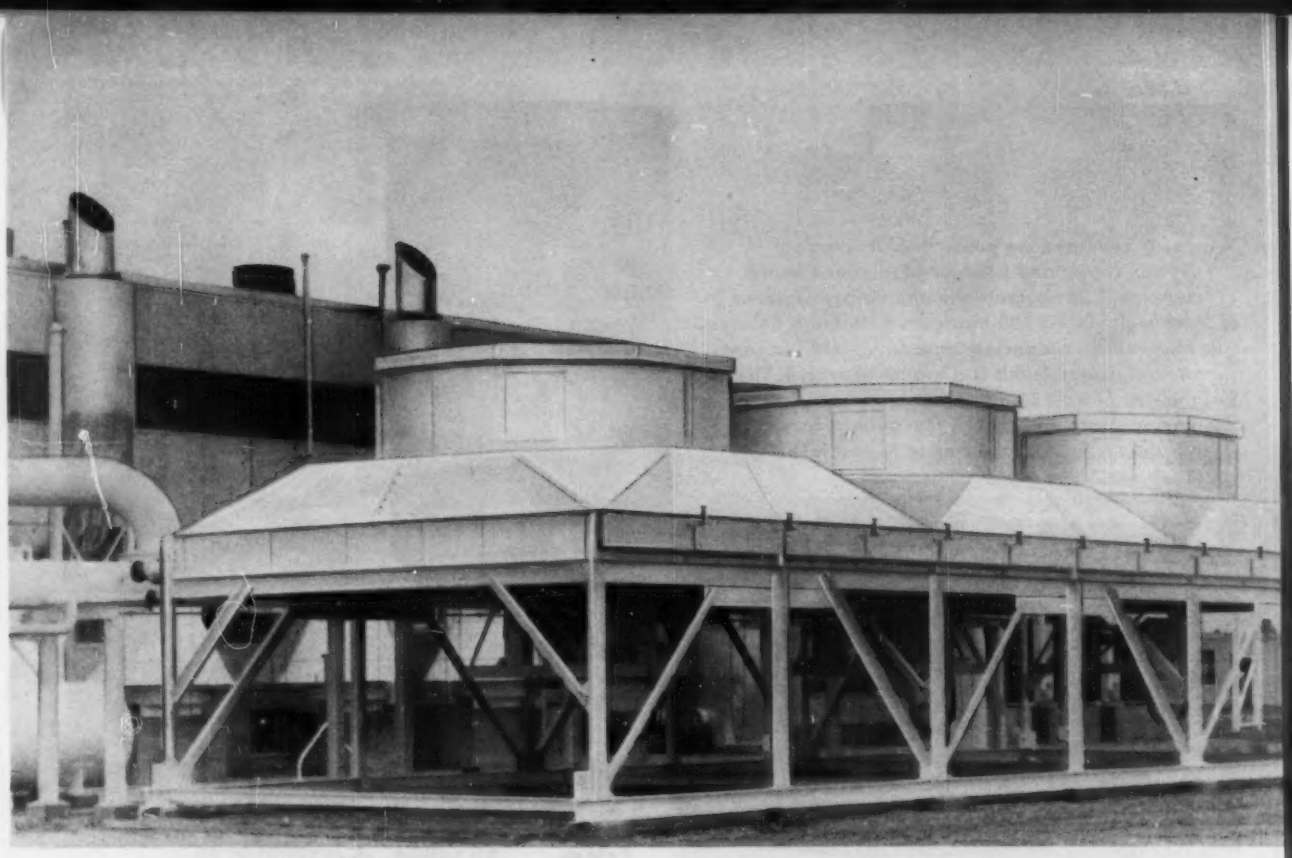


Giant compressor and generator engines are cooled by 26 TRANE Fluid Coolers at 6 Trans-Canada stations. Both horizontal and vertical air discharge types are used.

Trans-Canada, longest gas pipeline in the world, chooses Trane Fluid Coolers to cool engine water

The Trans-Canada Pipeline System—2,294 miles long—provides market outlets for reserves of Alberta natural gas, serves Western Canada, and the great industrial areas of Eastern Canada.

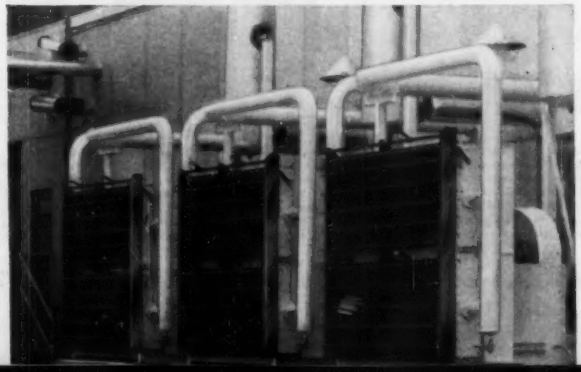
Because this pipeline passes through country where winter temperatures are very low, it was necessary to install engine jacket water cooling equipment that would function at 40 degrees below zero!

Trans-Canada chose TRANE Fluid Coolers for this important job. 26 TRANE units serve the initial six compressor stations. Air cooling was considered essential—and TRANE Fluid Coolers have shown that they can operate efficiently under all weather conditions.

More and more transmission companies are turning to TRANE for cooling equipment. Many have reported simplified maintenance, a minimum of adjustment problems. And engineers *know* that they can depend upon the accuracy and completeness of TRANE capacity ratings—tested in the industry's most complete laboratory, where as many as 90 different temperature readings are taken across the face of a heat transfer section!

When you have a fluid cooling problem, turn to TRANE! Just call your nearby TRANE Sales Office—or write TRANE, La Crosse, Wisconsin.

Small TRANE Horizontal Air Discharge Coolers cool the engines used to drive the 250-kilowatt generators (three per station) which supply electrical power on stations not served by a utility.



For any air condition, turn to

TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES

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with a Complete Line of

High Quality Refractory Products

The petroleum industry, throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

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In England: LIPTAK, LTD. London, England
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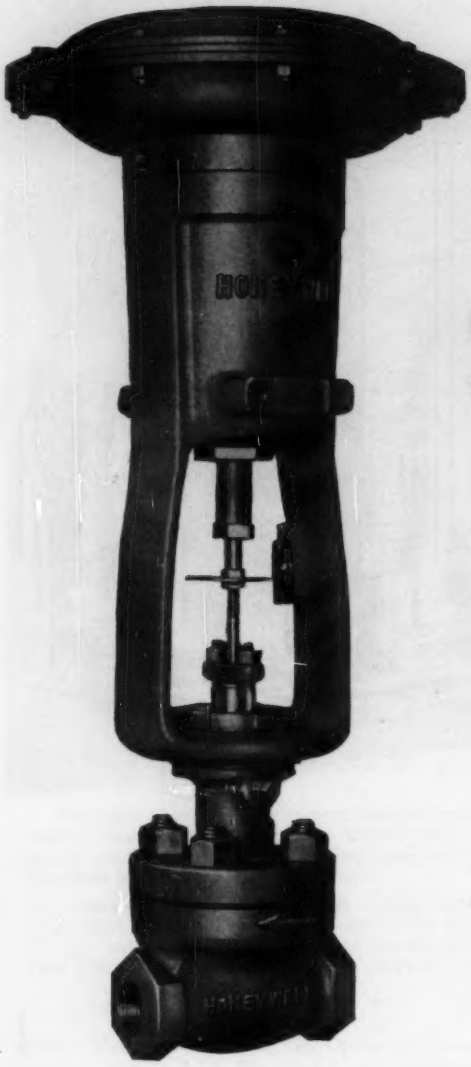
is your PROCESS FLOW SMALL?



Honeywell control valves are available for a wide range of flows

Whether your process flow is a trickle or a torrent, there's a Honeywell automatic control valve to meet your requirements. The Honeywell valve illustrated—Series 800, Type 14 Low Flow—is designed to control small process flows. For each body size, there are interchangeable reduced plug and seat ring combinations . . . with flow coefficients ranging from Cv 0.33 to 8.2. Ultra-low flow plugs are available with Cv's as small as 0.01.

For small or large flows . . . or other process flow conditions . . . Honeywell valves are available in a variety of types and sizes. When you need control valves . . . contact your local Honeywell field engineer. Write for new Catalog C800-1.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

Honeywell

First in Control

"I'm interested in boron trifluoride because it's an easy catalyst to work with" . . . Plant Superintendent

"I'm most interested in the high reactivity of boron trifluoride" . . . Research Director

"I've discovered that by using BF_3 we can simplify our plant designs" . . . Chief Engineer

What interests you most about Boron Trifluoride?

Whatever your reasons for investigating boron trifluoride, you'll find Baker & Adamson® is your best source of information. B&A has long been the leader in BF_3 research and production. B&A was the first to introduce boron fluoride etherate to industry . . . has shipped boron fluoride gas by tube trailer transport for many years—making it readily available in large commercial quantities. Today, B&A offers the widest range of BF_3 complexes, including ether, phenol, monoethylamine, other nitrogen and oxygen compounds. That's why—when it comes to BF_3 call on Baker & Adamson.

Useful product data bulletins

B&A has compiled extensive reference data on the use of boron fluoride gas and its complexes as efficient catalysts in organic synthesis. Boron fluoride's wide range of applications and its cost-cutting production advantages—such as its ease of catalyst removal—make it a factor to be considered in almost any organic synthesis problem. Write today for any or all of the free technical bulletins listed below:

TITLE	CODE No.
Boron Trifluoride, Compressed Gas	DA-34691
Boron Trifluoride, Compressed Gas Handling Information	TB-34691
Boron Fluoride Complexes with Nitrogenous Compounds	DA-3469-NIT-1
Boron Fluoride Complexes with Oxygen-Containing Compounds	DA-3469-OXY-1
Boron Trifluoride, Ether Complex, Tech.	DA-34711
Boron Trifluoride, Monoethylamine Complex, Tech.	DA-34661
Boron Trifluoride, Phenol Complex, Tech.	DA-34681

New book on Boron Fluoride

The most extensive study of boron fluoride to date is contained in a new book, "Boron Fluoride and its compounds as catalysts in organic chemistry," written by A. V. Topchiev, S. V. Zavgorodnii and Y. M. Paushkin. It discusses the use of boron fluoride as a catalyst in organic chemistry and also its derivatives and molecular compounds. Contents include physical and chemical properties; co-ordination compounds; compounds of boron fluoride in alkylation, polymerization, isomerization, cyclization, nitration and sulphonation reactions; condensation reactions in the presence of boron fluoride; and many other topics.

This book (price, $12) is published by Pergamon Press, Inc., 122 East 55th St., New York 22, N. Y.

BAKER & ADAMSON® Fine Chemicals

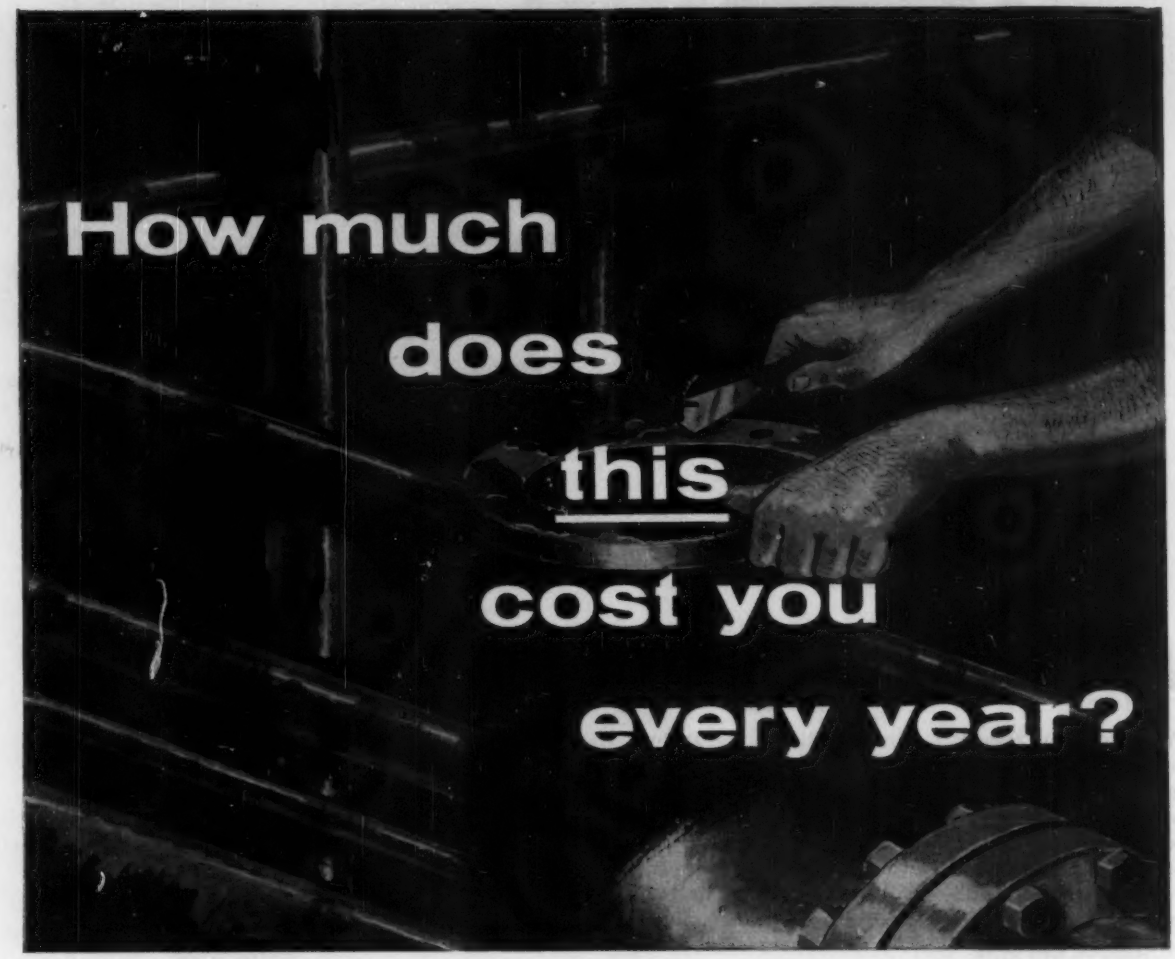
Allied Chemical

GENERAL CHEMICAL DIVISION

40 Rector Street, New York 6, N. Y.

For more data on advertised products use Readers' Service Cards, last page.

Maintenance Cost Too High?



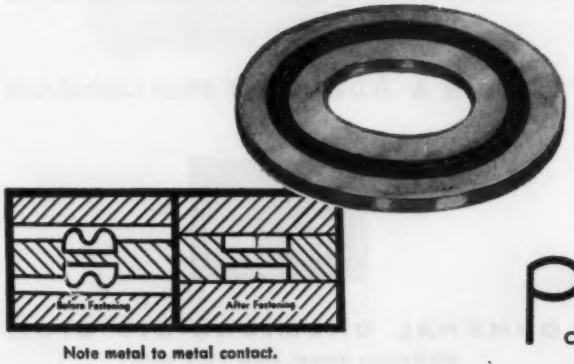
How much time, effort, and money is spent cleaning, resurfacing and/or replacing flanges to replace the seal!

Expensive? Yes!

Why not find out about Gask-O-Seals and save! Here are the facts: With Gask-O-Seal, flange faces require little or no cleaning or resurfacing of flanges when replacing the seal — *and Gask-O-Seals are re-usable.*

Gask-O-Seals save money and effort in many other ways, too. They are visually inspectable, do not need to be re-torqued, there is no material creep and they are non-directional, non-flexible, easy to install. They provide no-leakage sealing, *can not blow out,* and there is no wear due to pulse.

Now available to fit ASA standard flanges. Write for free catalog.



Note metal to metal contact.

Parker SEAL COMPANY

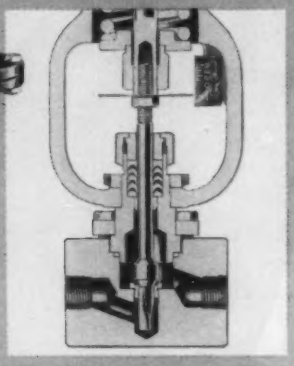
CULVER CITY, CALIFORNIA and CLEVELAND, OHIO

A DIVISION OF PARKER-HANNIFIN CORPORATION

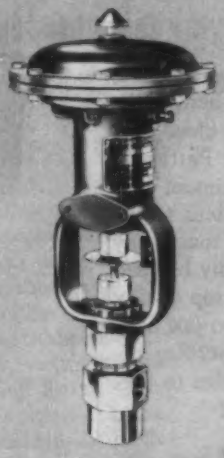
"Hand size" control valve for all corrosive applications

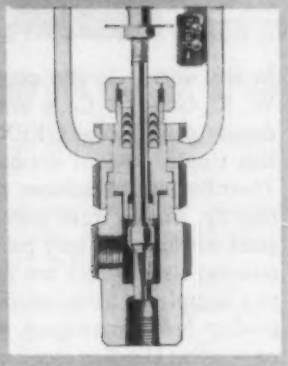
- **Inexpensive and highly dependable.**
- **Available in globe or angle body single port construction.**

Fisher now offers the low cost, dependable "BA" angle body and the "B" globe body valves for use on heavy duty applications involving corrosive liquids. Bodies are machined from 316 stainless steel bar stock, or other alloys such as Monel or Hastelloy. Either body can be supplied with Type 510 spring open or Type 511 spring closed diaphragm actuator. Normal diaphragm range 3 to 15 psi.



Type 510-B valve with globe body and bolted bonnet construction.





Type 511-BA valve with angle body and a union nut bonnet.

CONSTRUCTION AND SPECIFICATIONS	
Valve Body Sizes	½"- ¾" and 1" only with screwed end connections.
Inner Valve	Micro-flute or Micro-form.
Orifice Sizes	¼", ⅜", ½" and ¾" for the 1" size body. ¼", ⅜" and ½" for the ¾" size body. ¼" and ⅜" for the ½" size body.
Max. Body Pressure	1500 psi at 450° F.
Overall Dimension	Approximately 15" with the Type 510 or Type 511 topwork on either a "B" or "BA" body.

For complete information write for Bulletin 57 B.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER Controls

SINCE 1880

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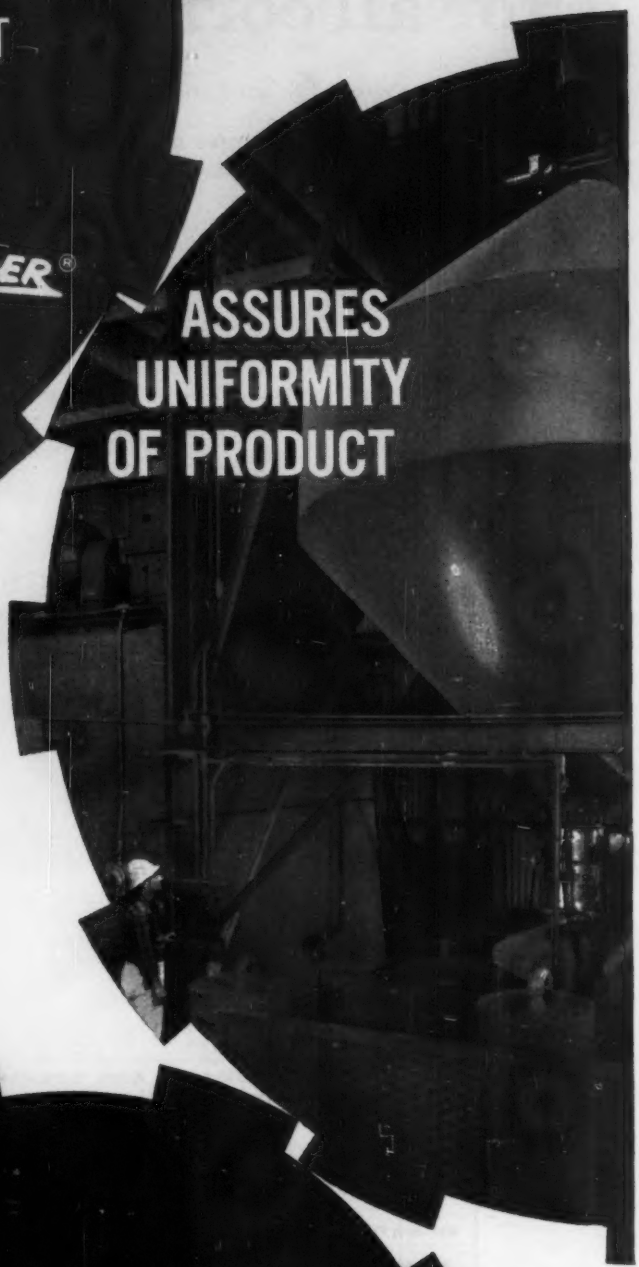
IN W. R. GRACE'S NEW

50,000,000 lb
POLYETHYLENE PLANT
AT BATON ROUGE, LA.

THIS 16-FOOT

Patterson THORO BLENDER®

ASSURES
UNIFORMITY
OF PRODUCT



In the world's largest plant of its kind, W. R. Grace & Co.'s brand-new, high-density polyethylene GREX is blended in this single, 16-foot diameter Patterson ThoroBlender to achieve maximum uniformity. Air-fed from storage bins to the giant machine, the poly pellets touch only stainless steel as they are rapidly blended to a completely homogeneous, top quality product before packaging. ● Do *you* have an exacting blending requirement? Regardless of scale, from laboratory-size to carload lots, check PATTERSON!

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PROCESS EQUIPMENT
OF ENDURING SATISFACTION

THE Patterson FOUNDRY AND MACHINE COMPANY
A Division of Ferro Corporation
East Liverpool, Ohio

THE Patterson FOUNDRY AND MACHINE CO. (CANADA) LTD.
Toronto, Ontario

COOPER ALLOY VALVE BRIEFS

THE VALVE AND FITTINGS ANSWER CORNER

Send in your questions on stainless valves and fittings to Carl Tylka, Cooper Alloy Technical Service Director.

Q. *Is it possible to obtain a valve which, like a globe valve, possesses linear throttling characteristics, but which also, like a gate valve, has low fluid pressure drop across it when fully opened?*

A. Not throughout the entire flow range of the size valve being considered. A very close approximation, however, may be attained with a Flex-Plug type design (a unique new valve patented by Cooper Alloy), which provides linear throttling response up to 90% of full valve flow. The 10% balance of the upper flow region would exhibit a typical gate valve flow pattern.

Q. *How can one prevent oxidation of active ferrite ion on the fluid side of a cast stainless valve body?*

A. This type of corrosion is commonly found on untreated cast stainless surfaces only, and may be caused by foundry, machinery, and handling techniques. Proper pickling and passivation with thorough mechanical cleaning will generally rectify this, though in some cases actual weld repair of the contaminated surface is required. Since this is a surface condition only, machining or grinding will also help.

Q. *What type of valve do you recommend for manual-control services where minimum pressure drop is required?*

A. In the absence of more detailed knowledge of the problem, I would tentatively recommend an angle valve. The pressure-drop characteristics of this type valve are less than 50% those of conventional globe valves.

Q. *Is it advisable to specify installed valve position on an order?*

A. Definitely. By inclusion of this information, definite design considerations can be incorporated, especially in cases where backseat leakages are critical and mechanical valve operation is involved.

Q. *Is it advisable to install valves smaller than the accompanying pipe sizes?*

A. Where flow and pressure considerations so permit, it is not only advisable but also economically beneficial.

Q. *Why aren't valve bodies with butt weld and connections made shorter?*

A. To prevent distortion of the seating surfaces during installation. The longer length is required for heat dissipation during welding.

Above left, Cooper Alloy 16" cast stainless gate valve ready to receive gear motor drive; lower left, Cooper Alloy 12" cast check valve. Both are rated for 2500 psi service at 670°F. Official AEC photo above shows them in place in nuclear process line.

Cooper Alloy cast stainless valves spurt ahead of competition to win acceptance in AEC's Spert III reactor program

Cast yield strengths of 23,000 psi, plus cost savings of 40%, do the trick!

This is a Cooper Alloy success story in another "first": casting of stainless valves and fittings to strength levels actually surpassing those previously possible only in forgings—and doing it all at a 40% saving to the customer!

The story starts, naturally, with the AEC's valve and fitting specifications, which are rugged indeed. They have to be certified to function continually at elevated pressures and temperatures (2500 psi, 670° F.), under which conditions leakage, corrosion, and other operational problems are magnified enormously over those encountered in normal process work.

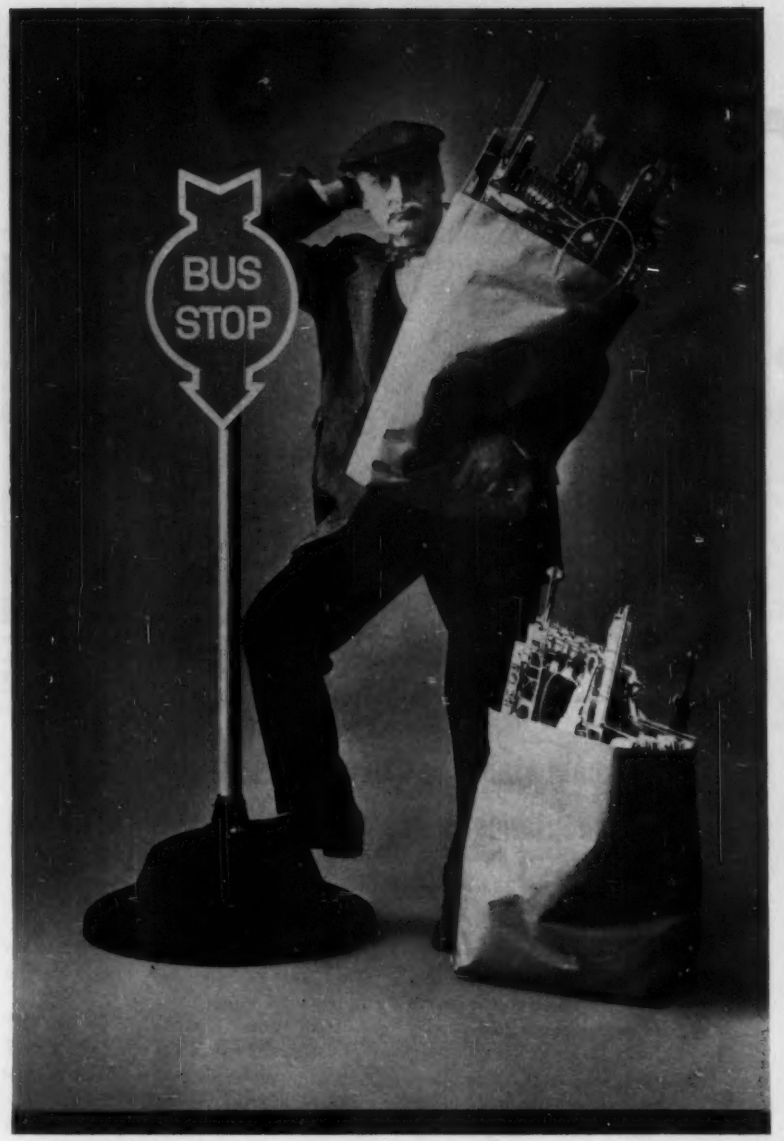
Prior to turning to Cooper Alloy, the contractor for the AEC cancelled a large valve order from another supplier, because the latter could not meet the exacting physical specs without changing the material specs. Cooper Alloy was given the order on the basis of producing to meet AE and AEC specs. Cooper Alloy valves and fittings are currently in operation in the AEC's Spert III installation at Arco, Idaho. Included are nuclear fittings, and motor and manual operated gate, globe, and check valves in various sizes.

How does Cooper Alloy do it? Through the use of the most advanced foundry methods, meticulous attention to conditions, and an exact balance of chemical composition to develop the maximum strength characteristics inherent in the complex structure of stainless alloys. All products, naturally, are elaborately tested and guaranteed before delivery.

As if the AEC's specs were not stringent enough, there is now a bonus to the story: during production, Cooper Alloy technicians worked out ways of producing cast strengths higher than those required, and proceeded to produce all fittings and valves to these higher, self-imposed standards—at cost savings of 40% over forged valves and fittings!

Unusual, yes, but not to Cooper Alloy. It's typical of the quality bonus you get when you buy from Cooper Alloy. For further information, write to Cooper Alloy Corporation, Hillside, N. J.

For more data on advertised products, use Readers' Service Cards, last page.



YOU—A SHOPPER?

Yes—you *must* be, in these days of ever-rising costs. A shopper's sense for comparing value received against price is an absolute necessity in considering catalysts, processes and services today.

Catalysts, for instance, appear to cost pretty much the same, no matter who makes them. But at HOUDRY, you'll find not only a wide choice of catalysts, but help in choosing the one which will make the *most money* for you. You have access to the experience of men who developed and who manufacture many catalysts now used in the petroleum industry, and advanced types for chemical processing, as well.

It's the same with our processes, and our services. From the breadth of our many years of work in developing processes and improving their performance in actual use, we can offer you some of the best talent in the petrochemical, petroleum refining, and chemical processing fields.

*HOUDRY

PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Penna.
*Houdry means Progress...through Catalysis

The Mail Box . . .

Allowable Load

To the Editor:

The Table of Economical Beams published on page 152 of your August issue gives for a 21WF73 for a span of 8 feet an allowable uniform load of 202 Kips. This, apparently, was transcribed from an early printing of the 5th Edition of the A.I.S.C. Manual which published this erroneous value.

The 21st printing (1957) gives an allowable uniform load of 251 Kips for this beam on a span of 8 feet.

W. J. Comery
Chief Draftsman, Lever Brothers Co.
New York City

Houdry Contribution

In PETROLEUM REFINER's August issue, "Get Better Curves From Your Data" was by-lined Murray Greyson and Joanne Cheasley, Cities Service Research & Development Company. Actually, this work was a contribution from the Research & Development Laboratories, Houdry Process Corporation, where Mr. Greyson and Mrs. Cheasley were working. The Cities Service by-line reflected Mr. Greyson's affiliation at the time he submitted the manuscript; he is presently affiliated with Operations Research, Inc., Silver Spring, Md.

Vessel Foundation Data Revisions Presented

The author of "Pressure Vessel Foundation Design," J. A. A. Cummins, has revised some of the material which appeared in PETROLEUM REFINER, October 1959.

Figure 1 in its revised form is shown here. The reader will note that the major change is to show the ordinate as p'/p instead of p/p'.

The author points out "the relationship between soil pressure at the side and that at the corner of a square base has been recalculated and is shown in the revised figure. This curve agrees well with previously established data, and has been derived by three separate methods. Note that the limit between Case II and Case III is now 4.24 and that the curve now shows p'/p being the ratio of soil pressure at the corner to that at the side. It may be seen that for all cases, the soil pressure p' at the corner is greater than that at the side. The direct computation of p' is somewhat complicated, whereas the calculation of p is relatively simple. Consequently, the curve may be used to great advantage to determine the maximum soil pressure for Cases I and II simply by multiplying the calculated value of soil pressure at the side p by p'/p. For Case III, i.e. where $\eta > 4.24$ it is simpler to compute

$$p' = \frac{W}{B^2} + \frac{M \times 6\sqrt{2}}{B^2}$$

in the usual manner. Referring to the first two examples in the published

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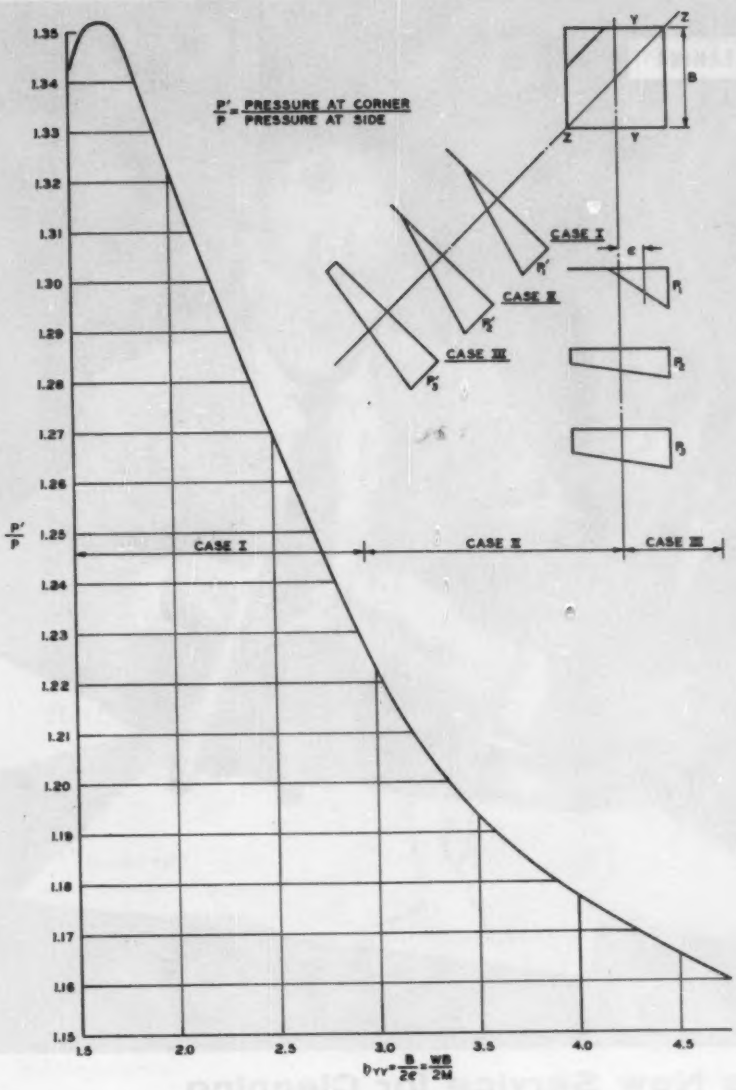

Figure 1, "Pressure Vessel Foundation Design"

article, the new curve will produce base sizes of 20.5 x 1.75 and 18.5 x 1.75 respectively."

In Example 1, the author points out that the maximum soil pressure equation should have been corrected by the factor p'/p. This would give a soil pressure greater than the given allowable of 4,000 psf. The next step for the designer, then, is to select a larger base, say 20.5 feet instead of 19.5 feet as originally selected, and repeat the mathematical steps. This will give a soil pressure less than the allowable.

The author also points out that the expression for the uplift moment, in Example 1, should have been

$$M_u = \frac{B^2}{8}(90\ f \text{ plus } 150\ D)\ (3 - \frac{1}{\eta_{min}})^2$$

and not

$$\frac{B^2}{8}(90\ f \text{ plus } 150\ D)\ (\frac{3}{\eta_{min}} - 1)^2$$

as shown.

In Example 2, note that w_e'' is equal to $w_e + w_l + w_p$ and that S_g is equal to w_o''/B^2. Note also that in the equation for the soil pressure, instead of dividing by p/p' as shown, multiply by p'/p from the new figure.

In the "Shear at Section" equation, Example 2, V_m is approximately equal to $\frac{4M_m}{B - C'}$ instead of being divided by the expression as shown.

In Example 3, the "Operating FOS Against Overturning" was shown as $\eta_o > 3.61$. This expression should have been $\eta_o > 4.24$.

The editors regret that these errors appeared in the original publication. Through a mishandling of proofs, certain corrections as well as a contemplated revision of Figure 1 were not made.

Example of

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Petroleum
A Refiner SPECIAL REPORT

Get the Most From Instrumentation

This check list way to better instrument application proposes standards for installation of instruments and their associated equipment

W. E. Bushnell*
Kaiser Engineers, Oakland, Calif.

THE INCREASING complexities encountered in the engineering and construction of process plants have brought into prominence some serious pitfalls in the smooth functioning of an over-all project. Let us center our attention on three of these dealing especially with instrumentation:

- Misunderstanding as to what the client believes he has bought and what the contractor believes he has agreed to supply.
- Shortage of capable instrument and process control application engineers to adequately and correctly instrument a process.
- Variations in methods of accomplishing similar applications throughout a project which has more than one instrument application engineer.

In an endeavor to eliminate these potential trouble spots, a comprehensive specification was written to assist in arriving at a philosophy of instrument application and selection. This specification is presented here to serve as a basis for developing an instrumentation specification philosophy for any specific project. It was formulated after extensive investigations with numerous companies and personnel.

*Present address: Atomic Energy Division, Allis-Chalmers Manufacturing Company, Washington, D. C.

Check These Items . . .

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Tubing and Wiring 99
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Any construction proposal should contain this specification check list or a similar check list. In this way it would serve to bring the client and the contractor into agreement as to what the project includes. Upon final agreement the specification would become a contractural document.

Fewer qualified instrument engineers are required to develop this type of specification list. Thereafter less experienced engineers can use the list to administer the project application.

This specification insures that similar applications will be done in similar manner throughout a project. This standardization will give savings in both construction and future maintenance.

General Considerations

This general specification establishes the method of instrumenting a process plant with the most economical instrumentation compatible with sound engineering and good operating and maintenance practices. Instrument designations are according to Company Standards. This is a modification of Instrument Society of America Recommended Practice ISA RP 5.1.

REFERENCE MATERIAL

Data and Drawings. The following instrument drawings and data are supplied for each project: instrument lists, material specifications, manufacturer information, instrument installation drawings, and instrument tubing drawings. Drawings other than instrument diagrams include: piping assembly drawings, architectural drawings, and electrical conduit drawings.

Instrument List. All instruments are listed according to item number on the instrument list. The list also shows service, material specification, location, and reference drawing of each instrument.

Material Specification. Complete specifications, which fully describe each instrument, consists of two parts: (1) a general specification defines the general design and performance requirements for each particular type of instrument, and (2) a material specification shows the operating conditions and detailed requirements for each particular item.

Manufacturer Information. The following manufacturers' information is supplied as applicable: (1) installation, operation, and maintenance instructions; (2) assembly drawings; (3) schematic and wiring diagrams; (4) spare parts list; and (5) controlboard arrangement drawings.

Instrument Installation Drawings. Two types of installation drawings are used as required: (1) schematic connection drawings, and (2) mounting drawings for instruments not on a controlboard. Generally these are typical and each drawing may be for more than one instrument.

Instrument Tubing Drawings. Instrument tubing routing and installation details are shown on the instrument tubing drawings.

CODES AND STANDARDS

Codes. Piping conforms to the latest revision of the American Standard Code for Pressure-Piping ASA-B .31-1. Wiring conforms to the latest revision of the National Electric Code.

Pneumatic Signals. Standard 3-15 psig pneumatic signals are used for transmission and control. In special cases, such as boiler control, a wider range-span may be used.

Pneumatic Connections. Instrument air supply and output connections are ¼-inch female NPT.

Electrical. All control rooms are classed as non-hazardous areas. Those in hazardous locations are pressurized and classed as non-hazardous areas. In these control rooms loss of static pressure will actuate an alarm on the panel annunciator. All control room electrical devices and wiring are general purpose. All locally mounted electrical devices and wiring conform to the applicable codes for the area classification. Instrument power supply is 110 volt, 60 cycle.

Electronic Signals. No standard electronic control signal is specified. Because signals vary, a complete electronic loop is purchased from one manufacturer.

Instrument Ranges. Direct reading charts and scales are used for all recorders and indicators with four exceptions: (1) differential-pressure type use 0-10 square root, (2) rotameter flow instruments use 0-100 linear, (3) level instruments use 0-100 linear, and (4) board mounted indicators for level and valve position use 0-100 linear. Standard ranges for instruments are selected so that the normal operating point is within approximately 40 to 70 percent of the range span.

Chart Drives. Three types of chart drives are used: (1) electric in non-hazardous areas, (2) penumatic escapement or impulse type in hazardous areas, and (3) spring-wound in hazardous areas.

ANALYZERS

General. Analyzers for pH, conductivity, oxygen, gas analysis, etc. are considered special. Detailed specifications will be written for these as part of the project design.

Flow Instruments

Three types of instruments are used to measure flow: differential-pressure manometers, area-meters, and positive-displacement meters.

DIFFERENTIAL PRESSURE METERS

Manometers. Differential-pressure manometers and orifice-plates are used for all flow applications which do not require displacement or area type meters. Manometers are the dry type, unless a uniform scale mercury type meter is required for process rangeability greater than the acceptable three to one when using the squared signal from dry type meters. Force-balance diaphragm units are used for all transmitting service except those on pulsating-flow applications. For these services, deflection bellows-type are used.

All mercuryless manometers have measuring system over-range protection equal to the measuring chamber pressure rating. The minimum pressure rating is 750 psig. Process connections are ½-inch NPT. Locally mounted flow-indicators, recorders, recording-controllers, or indicating-controllers are the deflection bellows type. Indicators, inaccessible for readings required for making control adjustments, are force-balance type transmitters with receiver-gages mounted for ease of reading. Bellows type manometers have a packless seal or a pressure-tight bearing and have an integral pulsation dampening device.

Orifices. In general, primary devices for differential-pressure manometers are square-edge concentric orifices with drain or weep-holes tangent to pipe inside surface. One drain or weep-hole is used for orifices up through 6-inch size. Two holes diametrically opposed are used for larger sizes. Orifice-plates are Type 304 stainless steel unless otherwise specified. Plate thickness is ⅛-inch for sizes 14-inch and smaller—¼-inch thick for 16-inch and larger. Flange taps are used through 12-inch pipe size. *Vena contracta* taps are used on larger pipe sizes. Where *vena contracta* taps are used the orifice plate is mounted between pipe line class conventional flanges. In horizontal lines, taps are at the top for gas and air service and at the side for steam, vapor, and liquid service. Orifice flanges are manufacturer's standard with flange-taps ½-inch NPT through 600 pound flanges and ¾-inch NPT for 900 pound flanges and heavier. Orifice-runs conform to a paper entitled, Piping Arrangements for Acceptable Flow-Meter Accuracy, contained in the ASME Transactions Volume 67, 1945. Straightening vanes are not used. Minimum pipe-size for orifice installations is 2-inch. Orifices are not located where a liquid is subject to flashing. Orifice tap valves are line classification gate valves. Tubing is used for meter lead-lines whenever possible.

Orifice calculations. The ratio of the orifice bore diameter to inside pipe diameter (beta ratio) is between 0.20 and 0.70. Beta ratios outside these limits are used only with specific approval. For the force balance diaphragm manometer applications orifice bores in even inches or fractions of inches are used with the meter differentials being adjusted to give round number multiplying factor and approximately a three-quarters scale reading for normal design flow. The number of orifice bores for each pipe size is minimized. For the bellows type manometer applications the bores are selected to fit the meter differentials. The preferred meter differential is in the neighborhood of 100 inches of water. Orifice calculations conform to the ASME Special Research Committee on Fluid Meters, Part 1, Fourth Edition, 1937.

Identification. Each plate is provided with a tab which projects beyond the flanges. The word "upstream," the item number, the plate material, the actual measured bore, and the ID of the pipe is stamped on the upstream side of the tab. The tab is in line with the drain or weep-holes.

Other Primary Elements. A flow-nozzle, venturi, pitot tube, segmental orifice, or eccentric orifice is used instead of a concentric orifice-plate only where it presents a specific advantage. Minimum pressure-loss, large line size, and elimination of plugging are some reasons for substitution.

Installation. Measurement errors due to long impulse-lines are reduced by locating instruments as near the orifice as possible. Transmitters are mounted at the orifice-flanges. Portable-ladder access is considered adequate. Meter manifolds are three valve type with plugged connections for draining or blowing down. Impulse-lines are sloped to eliminate liquid or gas pockets. Liquid and steam meters are mounted below orifice taps and gas meters are mounted above.

Flow Integration. All continuous flow-integration, except for displacement-meters, is accomplished in the control house by pneumatic receiver integrators or locally by cam-type integrators mounted in deflection type instruments.

Flow Compensation. Flow meters for accounting purposes have second pen for pressure or temperature for gas or liquid service respectively.

AREA METERS

Area-type meters are used for all measurements in lines 1½-inch and smaller, for highly viscous or highly corrosive materials, for fluids containing solids in suspension, and when rangeability greater than three to one is required. Maximum area meter size is four inches. Meters on hydrocarbon or steam service are the flanged armored type, either metal tube or glass tube within a pressure-sealed enclosure. Glass tube meters with light metal protective cases are used for air and water unless the pressure or temperature exceeds the meter rating. Then the armored type is used. Indicating scales are calibrated 0 to 100 and a scale factor is used.

Transmitters. Area-meter transmitters are the deflection type. Local indication is by a deflection pointer and scale on a receiver gage in the transmitter case. Area meter pneumatic transmitters transmit from 4.2 psig to 15 psig corresponding to 10 to 100 percent of range. Electric transmitters transmit to a corresponding range.

DISPLACEMENT METERS

Displacement meters are used only when required for batch operations, totalizing only, or when rate of flow is not required. Package equipment may include displacement-meters as integral units. Meters in hydrocarbon service have steel bodies with 150 pound minimum flange-connections and flanged-body construction. Meters in utility-type service, such as water or air, may be of bronze or cast-iron construction with screwed connections up to 1½-inch size and 125 pound minimum flanged-connections 2-inch and above. Each meter has a totalizing counter with a 5-digit minimum non-reset totalizer. Counters read in U.S. gallons or units of ten U.S. gallons. Counters are weatherproof and suitable for outdoor installation.

Strainers. A strainer immediately precedes each displacement meter. Strainer material and mesh are suitable for the meter and fluid.

Pressure Instruments

Three types of instruments are used to measure pressure: bourdon tubes, bellows, and diaphragms.

PRESSURE ELEMENTS

Bourdon Tubes. Bourdon tubes are used for all gage pressure applications with range spans 15 psi and larger. Bourdons or bellows are used for 3-15 psig pneumatic receiver gages. Siphons are used for all vapors above 300 F. Clean-out diaphragm type chemical protectors are used with pressure gages where the measured material will clog the measuring element. They are also used where the measuring element cannot be made of a material that would withstand the process fluid.

Bellows. Gage-pressure ranges of 0-5 to 0-15 psig and all absolute pressures are measured with bellows type elements. Local pressure gages use bellows for ranges from 0-50 inches of water to 0-15 psig.

Diaphragms. Gage-pressure ranges below 5 psig and near atmospheric pressure are measured with diaphragm elements.

TRANSMITTERS

Deflection Type. Pressure transmitters are the indicating deflection type with three exceptions: (1) ranges suppressed more than 25 percent of instrument range, (2) transmitters for control service, and (3) differential pressure service.

Force Balance Type. Force-balance transmitters are used where pressures are suppressed more than 25 percent of the instrument range, and for control applications. The measuring element may be either a bellows or a diaphragm. The range and range-span are adjustable. Differential-pressure transmitters are in accordance with the previous section on "Flow Instruments."

Pressure Gage. Local pressure indication is by 4½-inch phenolic turret case pressure gages. All cases have blow-out discs. Movements are stainless steel with nylon bearings and pinion gears. Bottom connections are ½-inch male NPT.

Self-Actuated Regulators. Self-actuated regulators are used under the following conditions only: (1) where a variation of ten percent from the control point is acceptable, and (2) where the operating pressure is below 150 psig. The limit for valve size is 1½-inch for single-seated and 2-inch for double seated.

Pressure Pilot Control. Application of pneumatic pressure pilots is covered in a later section on "Controllers."

Pressure Switches. All switch cases are dust tight. In addition, local pressure switches have weather-tight cases. Cases suitable for Class 1, Group D, Division 1 or 2 atmospheres (National Electric Code) are used where switch is located in a hazardous atmosphere. The set point and differential adjustments are external to the explosion-proof housing. All switch mechanisms are approved single pole double-throw.

Process Connections. All screwed and socket-weld process pressure connections are ½-inch. All flanged process pressure connections are 1½-inch, rating and facing in accordance with the nozzle specifications for the piping or vessel.

Temperature Instruments

All temperatures are measured with thermocouples or resistance-bulbs with two exceptions: (1) Temperature controllers, single-point remote indicators, and single or dual-point remote recorders used filled-bulb force-balance pneumatic-transmitters up to 800° F. (2) Bimetallic dial thermometers are used for local temperature indication to 750° F.

Dial thermometer check points are used at all filled-bulb non-indicating transmitters. Potentiometric check points are used for all remote temperature controllers only on customer's request. For filled and resistance-bulb control points the check thermocouple well is located near the filled or resistance-bulb well. For potentiometric control points, the check thermocouple is part of a duplex

thermocouple in a single well. Single thermocouples are not permanently connected to more than one instrument.

ELECTRONIC NULL-BALANCE INSTRUMENTS

Applications. Electronic, null-balance instruments are used for two general temperature applications: (1) multipoint temperature-recorders, and (2) multipoint temperature indicators.

Types. All null-balance instruments are calibrated for direct reading of the type of thermocouple or resistance-bulb used. Thermocouple calibration is in accordance with ISA RP 1.6 of the Instrument Society of America. Calibration for resistance-bulbs is the manufacturer's standard. All potentiometers have upscale burnout and automatic reference-junction compensation. Special applications such as molten metals require downscale burnout.

Multipoint Recorders. Each point is identified on the chart by numbered dots or crosses. When a recorder uses two or more types of thermocouples or resistance-bulbs, it has multiple scales—one for each calibration. The chart has only one calibration. Recorders have automatic standardization and automatic chart reroll.

Multipoint Indicators. A maximum of 48 points may be connected to a single instrument. Selector-switches are toggle or push-button type with spring-return to open position and are mounted on instrument door. When an indicator uses two or more types of thermocouples or resistance-bulbs, it has multiple scales—one for each calibration. All indicators have manual push-button standardization.

PNEUMATIC INSTRUMENTS

Temperature Transmitters. In service below 800° F, pneumatic temperature transmitters are filled-bulb, force-balance type with fixed range-limits and adjustable range-spans. Transmitters do not have rate action except as required to overcome measurement and transmission lags in control service

Measuring Element. A nominal ⅜-inch diameter bulb is used. The bulb is factory connected to the transmitter by armored capillary-tubing. The tubing length is normally 18-inches.

Electric-to-Pneumatic Transducers. Large-case control instruments are not used on the controlboards and all boardmounted pneumatic controllers are the miniature type. An electric-to-pneumatic transducer is used for each temperature control point over 800° F. These transducers locate on the rear of the controlboard or on a rack behind the controlboard.

LOCAL INSTRUMENTS

Application. In services below 800° F, where the instrument is localmounted, filled-bulb deflection type recorders and indicating or recording controllers are used. Also, this type is used for indication where a bi-metallic thermometer would not be visible. The bulb-size and filling is selected to be compatible to the range and service and is factory connected to the instrument by an extension neck and armored capillary tubing. Where the filled system is affected by ambient temperatures, the instrument has case and capillary compensation. The maximum length of the capillary is 150 feet. On applications that would require longer lengths, a transmitter-receiver combination is used.

Self-Actuated Regulators. This type of regulator is used under the following conditions only: (1) where a variation of ten percent from the control point is acceptable, (2) where the operating pressure is below 150 psig, and (3) where the operating temperature is below 350° F. Single-seated valves are limited to 1½-inch size. Double-seated valves are limited to 2-inch.

THERMOCOUPLES

Types. Three types of thermocouples are used: copper-constantan Type T for temperatures from minus 300° to plus 700° F, iron-constantan Type J from 0° to 1,100° F, and chromel-alumel Type K from 600° to 2,000° F. In the overlapping ranges, the type is selected to provide consistency of type on any one multipoint instrument. All thermocouples are 14 AWG except 8 AWG is used in fired heater service. Temperature limits for other wire gages and other materials are in accordance with ISA-RP 1.3. The fabrication is in accordance with ISA RP 1.4.

Thermocouple Assemblies. All thermocouple assemblies are purchased assembled and include a single- or duplex-couple, a thermowell, a ½-inch pipe nipple 2 inches long, and a head-assembly for ½-inch conduit.

Extension Wiring. All thermocouple extension wire is 16 AWG. Copper-constantan is used with copper-constantan thermocouples, iron-constantan with iron-constantan thermocouples, and chromel-alumel with chromel-alumel thermocouples. Extension wire insulation is polyvinyl chloride cover over polyvinyl chloride on each wire for ambient temperatures up to 220° F. Over 220° F, asbestos braid over asbestos is used. Extension wire, between the thermocouple head terminal block and the instrument terminals, is run without splices with one exception—a terminal box may be used at the controlhouse to facilitate installation of large numbers of leadwire.

RESISTANCE-BULBS

Application. Resistance-bulb temperature elements are used for two general applications: (1) narrow-spans, and (2) temperature differentials. Also, some temperature compensators for other measurements require the precision and linearity for resistance elements.

Types. Since there are no Bureau of Standards calibrations for industrial resistance-bulbs, the calibrations used are the manufacturer's standard and the following temperature limits are somewhat flexible. Platinum elements are used for temperatures from minus 300° to plus 1,200° F, nickel from minus 300° to plus 600° F, and copper from minus 40° to plus 250° F.

Head Assembly. The resistance-bulb head assembly is the same as that for thermocouples except that the terminal block provides for 3-wire resistance elements.

Complete Assemblies. All resistance-bulb assemblies purchased assembled and include a resistance element, a thermowell, a ½-inch pipe nipple 2 inches long, and a head assembly.

Wiring. All leadwire of the three-wire circuit for resistance elements is 16 AWG copper wire. The third or compensating wire is not made common for multiple elements.

THERMOMETERS

Types: Local thermometers are the bimetallic-actuated heavy-duty weatherproof dial type with 5-inch diameter face and ½-inch male NPT back- or bottom-connection. Standardize on four overall stem-lengths: 6, 9, 12, and 18 inch. Stem diameter is ¼-inch.

Dial ranges are shown in the following table:

Recommended Dial Ranges	
Operating Temperature, ° F	Dial Range, ° F
— 40 to + 50	— 40 to +120
51 to 150	0 to 200
151 to 350	50 to 400
351 to 750	150 to 750

THERMOWELLS

Well Types. Thermowells are provided for four general uses: (1) as a part of a thermocouple or resistance-bulb assembly, (2) for filled-bulbs, (3) for dial thermometers, and (4) for test-wells where a measuring element is not supplied. Thermowells for use with dial-thermometers and filled-bulb thermal systems are purchased with the instrument.

Construction. All wells are bored from solid barstock except a protecting tube that is spun and welded 1-inch Schedule 80 seamless pipe. A lagging extension for pipe or vessel insulation is provided where required.

Interchangeability. Thermocouples and filled-bulbs are interchangeable from one well to another. Either can be inserted in a test well. The dial-thermometer thermowells are not suitable for other elements because of the smaller bore at the bottom of the well.

Thermowells for thermocouple, filled-bulb, or test well use have a straight ⅜-inch bore and are for use with an element assembly of not greater than 0.360-inch diameter. The dial-thermometer thermowells have a bore of ⅜-inch diameter at the upper end stepped to ¼-inch diameter at the bottom.

Connections. All thermowells have a ½-inch NPT female thread for connection of the measuring element. Well-mounting connections may be screwed, socketweld, or flanged. Screwed connections are used in accordance with piping material specifications. Socketweld connections are used wherever possible in preference to flanged connections. All screwed and socketweld mounting connections are ¾-inch except for the protection tube which is 1½-inch. All flanged connections are 1½-inch, rating and facing are in accordance with the nozzle specifications for the piping or vessel.

Materials. In general, the well material is Type 304 stainless steel unless the application requires a higher alloy. Carbon-steel flanges may be used on stainless wells where the piping or vessel connection is a carbon steel flange.

Test Wells. Each test well has a ½-inch brass plug, chain-connected to the well.

Special Wells. A protecting-tube well is used for such applications as fired-heater flue gas temperatures and similar points not requiring a barstock bored-well. The protecting-tube is 1-inch Type 304 stainless steel with a 1½-inch mounting connection. Other special wells or protecting tubes must be approved by customer.

Level Instruments

Four types of measurement are used: (1) gageglass, (2) float and tape, (3) float-actuated, and (4) differential-pressure.

APPLICATION

Gageglasses. Flat-glass reflex-type gageglasses are used for local level indication. There are five exceptions: (1 interface, (2) very high viscosity fluids, (3) caustic, and (4) steam and condensate above 300 psig. All of these require through-vision or transparent gageglass. For caustic service, shields of chlorotrifluoroethylene resin are used. For high pressure steam, mica shields inside of the glass are used. (5) Tubular gageglasses are used for non-hazardous fluids in atmospheric vessels not over 8 feet high. Maximum center-to-center distance between tubular gageglass valves is 36 inches.

All reflex and transparent gageglasses have ½-inch female NPT end connections. Gageglass valves are angle-pattern offset type with internal ball-check. The valves have union tank connections, ¾-inch male NPT or 1½-inch flange in accordance with piping- and vessel-specifications. Valves connect to gageglasses with ½-inch Schedule 80 nipples. Vent and drain connections are barstock plugged.

Float and Tape. Local level indication for large tanks at or near atmospheric pressure is by a float and graduated tape. The level is read directly in feet from the tape at a convenient elevation. This type may be used with a transmitter for remote indication or recording. For atmospheric tanks less than 20 feet in height, the gageboard type level indicator is used. It uses a float positioned target on a vertical wooden scale.

Float-Actuated Devices. Float type instruments are roughly classed as ball or spherical floats, and displacer or vertical cylindrical floats.

Ball float instruments are used for narrow range level control where rapid fluctuations in the controlled line flow can be tolerated and changes in control point are

not required. Such applications are head tank charge, product vessel effluent to storage, condensate collection pots and knock-out drum effluent. The packless flexible shaft type is used. Ball float instruments are also used for level alarm switches.

Displacer instruments are used for control ranges less than 20 inches of water equivalent where one of the following conditions exist: (1) Rapid flow fluctuations in the controlled line are not acceptable. (2) Surge volume is critical. (3) It is desired to be able to change control point. Displacers are also used for control ranges larger than 20 inches of water equivalent when differential-pressure measurement would require complex purges or seals.

Differential-Pressure. Differential-pressure instruments are used for all other level measurements not covered in the preceding paragraphs. Bubbler dip tubes are used in vessels where connections below liquid level are prohibited or such connections are subject to plugging. The deflection bellows type manometers with integral pneumatic control pilot are used for local control. Force-balance and diaphragm-type manometers are used for level transmission to remote controllers or indicators.

INSTALLATION

Floats. Internal floats are used for all float applications except where failure of the level element would require a process shutdown. These applications use floats in external cages. External floats are not used for interface service. External floats used for fluids containing solids or for extremely viscous fluids require liquid purges.

Vessel Connections. Connections for float instruments are 4-inch for internal floats, 2-inch for external floats, and ½-inch couplings for differential devices.

All level instruments are connected directly to the vessel. One exception—where three or more level instruments, other than those in interface or alarm service, are required, a 2-inch pipe column, or bridle, is used with isolating block valves for each instrument. All level switches for alarm service are mounted directly on the vessel.

Transmitters and Receivers

Transmission, pneumatic or electric, is used for the following: (1) controlhouse instruments, (2) to isolate process fluids, (3) to restrict impulse lines between process and instrument to a maximum of 100 feet, and (4) to speed control response by the use of local-mounted controllers.

PNEUMATIC TRANSMITTERS

Types. Force-balance transmitters are used where possible. The selection of force-balance or deflection-type transmitters will be in accordance with the previous measurement specification sections.

Indicating Transmitters. Transmitters, without indication or an integral output pressure gage, have a 2-inch, 0-30 psig pressure-gage connected to output tubing.

Electro-Pneumatic Transducers. These are applied to temperature transmission, as outlined in the section on "Temperature Instruments."

PNEUMATIC RECEIVERS

Indicator Types. The following types of receivers are used for all applications: (1) a 3½-inch round-dial type for local mounting or where measured variable is not visible at a valve, (2) a 4½-inch round-dial type for local or central controlboards, and (3) miniature board-mounted indicating control stations.

Recorder Types. All receiver-recorders are miniature, rectangular case. There are two exceptions: (1) large-case recorders are used for local applications, and (2) large-case pneumatic multipoint recorders may be mounted on controlboards.

ELECTRONIC TRANSMITTERS AND RECEIVERS

General. A later section on "Controllers" outlines the application of electronic transmission in conjunction with electronic control.

Transmitters. The transmitter employs a conventional primary measuring element to produce, through linkage and feedback circuitry, an electronic signal proportional to the process variable. For hazardous locations, the transmitter is housed to meet electrical code requirements. Where a thermocouple is used in conjunction with electronic control, an electronic transducer converts from millivolts to the electronic transmission signal.

Receivers. The electronic receiver is a boardmounted miniature control station. Separate indication may be provided by a round-case dial voltmeter or ammeter.

TELEMETERS

General. A telemetering system is used for transmission of measurement for distances exceeding 1,000 feet. It is used for all such applications except those involving process control.

Transmission. The telemetering transmitter includes a standard measuring element which actuates an electric impulse mechanism. Transmission is over telephone wires. The receiver has an impulse device to convert signal received to a measurement pen position. The transmitter is usually an indicator, the receiver a recorder.

Controlboards

There are two general types of controlboards: conventional and graphic. The graphic controlboard has a simplified flowdiagram display on the front. There are degrees of graphic displays ranging from one with all the instruments in the display to a smaller graphic display with all instruments outside the display. The conventional controlboard has no graphic display although the instruments are arranged in process sequence. Piping and wiring conforms to the latest revision of these codes: American Standard Code for Pressure Piping ASA-B.31-1 and National Electric Code, 1956.

CONSTRUCTION

General. Controlboards are free standing assemblies complete with instruments and all piping and wiring. Vertical strut supports are used for accessory mounting. Front of controlboard background color and back of board surfaces are light green. Instrument bezels and graphic symbols are a darker contrasting green. For gaphic panels a schedule is prepared showing the graphic line color for each process fluid. Directional arrows match the graphic line color.

Controlhouse Controlboards. Controlboards are a self-supporting box-like angle-iron frame with ¼-inch laminated phenolic material over 3/16-inch steel plate front. The depth is 26 inches. The panel base in front is a 5-inch channel recessed 1½-inches from the face of the panel. The base in back has adjustable legs. Panels are 7 feet 11 inches high from the bottom of the channel-base to the top of the panel. A 1-inch grout is used under front channel in installation making an over-all height of 8 feet 0 inches from floor level.

Vertical panel joints are made as required for ease of fabrication and shipment. Horizontal panel joints are not used.

Filler panels of the same type construction as the controlboards are used between the top of the controlboard and the controlroom ceiling. They are bolted to the top flange of the controlboard.

Field-Mounted and Local Controlboards. The boards are self-supporting cubicles with overhead canopies. The canopies extend 30 inches from the face of the board. Over-all height of the canopy structure is 8 feet 6 inches. The depth of the cubicle is 26 inches. The controlboard faces are ¼-inch painted steel plate. The canopy cover and side panels are 11 gage or ⅛-inch steel plate. All exposed edges are slightly beveled or rounded for a chip-free painting surface. The rear of the controlboards are closed with hinged weatherproof access doors. The front of the board is lighted by lights in the canopy. Lights are also provided inside the cubicle.

GRAPHIC DISPLAY

Symbols and Lines. Graphic symbols are 1/16-inch thick laminated phenolic material or raised aluminum. glued to the controlboard. Symbols for pumps, exchangers, and similar small equipment are 1¼-inch diameter. Vessels and large apparatus symbols are large enough to provide a minimum of ½-inch border outside any instrument case within the symbol. Graphic lines are 1/32-inch thick laminated phenolic material. Main process lines are 13/32-inch wide. Secondary process lines are 9/32-inch wide. Instrument lines are 5/32-inch wide. Where a line continues into a symbol, the line is painted on the symbol the same color and width.

Symbol Inscriptions. Symbol names and numbers are engraved on the symbols. Engraving is filled with black paint. White paint is used when black will not contrast with a dark colored symbol.

NAMEPLATES

Front-of-Board. Nameplates are clear plastic back engraved. Engraving is approximately ⅛-inch high and is filled with black paint. Back of nameplate is painted to match the controlboard. Nameplates are mounted inside instrument doors where a clip is provided.

Back-of-Board. A nameplate is mounted adjacent to each instrument and at each piping- or wiring-terminal. Engraving is white on a black background. Instrument nameplates are permanently attached with screws on the rear of the panel. Nameplates for miscellaneous devices and terminal identifications are any type of rigid material attached by means of screws or clips.

INSTRUMENTS

Types. Miniature instruments are used on all controlhouse controlboards. Large-case instruments are used for three applications: (1) multipoint potentiometric and bridge type instruments, (2) where an equivalent miniature instrument is not available, and (3) where the use of a miniature instrument requires additional instruments. Indicating receiver gages are the 4½-inch round dial type. Large size instruments may be used on outdoors controlboards and on direct measurement applications on indoor local controlboards.

Instrument Arrangement. All instruments are located in a modular pattern on the controlboards. For miniature instruments, the horizontal spacing between vertical centerlines is 11 inches. The vertical spacing is 10 inches. There are four horizontal rows, the horizontal centerline of the bottom row is 33 inches above the floor. Middle rows are at 43 and 53 inches. The top row is at 63 inches. Deviations from this modular arrangement are made only where a graphic display requires it. Pressure switches are located on the rear of the panel. For large size instruments, the horizontal spacing between vertical centerlines is 22 inches. There are two horizontal rows. The bottom of the top row is 49 inches above the floor. The top of the bottom row is 45 inches above the floor.

PIPING

Tubing. All instrument-air lines are ¼-inch OD polyethylene and color-coded in so far as possible. All tubing leaving the controlboard is terminated at the top rear of the frame.

Air Supply. The air supply is a 1-inch minimum, brass air header running the full length of the controlboard along the bottom rear of the frame and is pitched to a drain valve at the end. Pressure regulation is by two filter-regulators in parallel, each sized for the maximum capacity of the installed instruments plus 25-percent. A local 4½-inch pressure gage and a 30 psig relief-valve are part of the filter-regulator station. A pressure switch on the outlet of the filter-regular station operates a low pressure annunciator. Provision is made for 10-percent spare instrument supply takeoffs. Air supply for local panelboards with six air-using instruments or less have one air filter and regulator set only.

ELECTRICAL

Controlhouse Controlboard. Controlhouses are classified as non-hazardous areas. Pressurization is provided, if necessary, to prevent entry of hazardous atmospheres. General purpose instruments, electrical devices, and wiring are used. Chart drives are electric. Power and alarm wiring may be run in the same conduit or wireway. Thermocouple wiring and other signal circuits are run in conduits separate from the power and alarm circuits. Wire is thermoplastic with 600-volt insulation. In general, use 18 AWG wire. Do not use smaller than 22 AWG. Three-prong twist-lock type receptacles are used instead of switches for all instrument power supplies. Connections between twist-locks and instruments are made by rubber-covered three-conductor cord. The third wire is grounded to instrument and conduit.

Local Controlboards. When local controlboards are located in non-hazardous areas, the electrical specifications are in accordance with the foregoing paragraph. When they are located in hazardous area, all instruments, electrical devices, and wiring are suitable for operation in a National Electrical Code, Class 1, Group D, Division 1 or 2 hazardous area. Galvanized rigid-steel conduit is used, the minimum size is ½-inch.

ALARMS

Alarm System. Visual and audible alarms are provided to protect personnel, equipment, and product quality. The annunciator system is mounted on the controlboard. In controlhouses and other non-hazardous areas, the annunciator system includes, in addition to an audible signal, a back-lighted nameplate for each point. In hazardous areas, the visual signals are explosion-proof bullseyes with identifying nameplates mounted below the lights. Alarm sequence is: Normal—light dim and horn off; Abnormal—light flashing, horn on; Acknowledge—light steady, horn off; Return to Normal—light dim and horn off. The system operates on 115-volt AC power and alarms on open signal circuits. One audible signal and one acknowledge pushbutton is provided for each controlboard.

Controllers

This specification covers types and application of pneumatic, electronic, and self-regulated controllers. Special types, such as time-schedule controllers, are defined in procurement specifications. Pneumatic control is used except when distance and time lag limitations require the application of an electronic system. Self-actuating controllers will be used where applicable.

CONTROL FUNCTIONS

General. The following paragraphs give the control functions used for control of various process variables. Certain applications may require other selections.

Flow. Flow controllers have proportional plus reset functions. Rate action is not used. Proportional band is adjustable to a minimum of 200 percent. Valve-mounted controllers are used for field mounting.

Pressure and Temperature. Pressure and temperature controllers have proportional, proportional plus reset, or proportional plus reset plus rate function, depending on the application.

Level. Level controllers have proportional function only with two exceptions: (1) where the rate of change of the flow through the line containing the control-valve is critical (such as the line feeding of a column), and (2) where surge-capacity of a level-controlled vessel is critical and the operating level can not be permitted to stay away from the control point. These two applications have proportional plus reset functions.

Cascade Control. The master instrument has proportional plus reset functions, plus rate if required. The slave instrument has proportional function only except the reset function may be added when the controlled variable is subject to supply changes.

PNEUMATIC CONTROLLERS

Controlhouse. Controllers on central controlboards are the force balance or stack type. The controller is mounted on the back of the recording or indicating instrument chassis. The controller is adaptable to field mounting.

Local Controlboards. Controllers on local controlboards may be either conventional or miniature instruments.

Field Mounted. Field mounted controllers set from remote locations are the force-balance or stack type with weatherproof cases. For flow applications only, a field mounted controller is valve-mounted and has a fixed proportional band. Local level controllers have the controller as an integral part of the instrument.

Valve Mounted Controller. Weatherproof valve mounted pilot type controllers are used for pressure and temperature applications where a proportional band less than 50-percent is adequate.

Controller Locations. The location of controllers used with controlboard mounted instruments is according to the following limits. For distances up to 150 feet from controlboard to control valve, the controller is board-

mounted. For distances from 150 to 250 feet, controller is boardmounted with a one-to-one volume booster used at the control valve unless the valve has a positioner. For distances from 250 to 500 feet, a field mounted controller at the valve is used. Over 500 feet, electronic control is used. Unusual process or control loop time constants may require exceptions.

ELECTRONIC CONTROLLERS

General. An all-electronic control loop is used when transmission distance and control time lags make pneumatic control difficult. (Also see preceding paragraph.)

Mounting. Electronic controllers are the plug-in type and are mounted in the controlhouse on the back of miniature indicating or recording instrument chassis. No electronic controllers are field mounted.

SELF-ACTUATED CONTROLLERS

General. Self-actuated regulators for flow, pressure, or temperature control are used with certain conditions: (1) when a variation of ten percent from the control point is acceptable, and (2) where the operating pressure is below 150 psig. The limit for valve sizes is 1½-inch for single-seated, and 2-inch for double seated.

☑ Control Valves

This specification covers the selection and the construction of control valves and control valve operators.

CONSTRUCTION

Body. For process applications, minimum body material is cast-steel. Cast-iron is used for air and water service below 125 psig. Minimum body size is 1-inch. Valves smaller than 1-inch are reduced inner valves in a 1-inch body. Flanged valves are used for all sizes 1½-inch and larger. Flange rating is at least that of line-pipe flanges with a minimum rating of 300 pounds ASA. Minimum rating for screwed-end steel valves is 600 psig. For cast-iron, 250 psig. Face-to-face dimensions conform to ISA RP 4.1 where applicable.

Inner Valve. Inner valves are the top and bottom guided high lift type. Two exceptions are: (1) small valves of the top guided piston type, and (2) high pressure-drop angle-type valves which also are the top guided type. Minimum control valve trim material is stainless steel. The trim includes plug, seats, stem, guide bushings, and stuffingbox gland. The guide bushings are normally a different stainless to prevent galling action with the stem. Nickel-molybdenum stainless steel plugs and seats are used for high pressure-drop or high temperature applications. Hardened stainless steel is used for small valves when more economical.

Stuffingbox. The bolted type stuffingbox is used. A tetrafluoroethylene resin is used for stem packing for process temperatures up to 450° F. For body temperatures from 450° F to 1,000° F, suitable cooling fins are used to lower stuffingbox temperatures below 450° F. Smooth-surface extension bonnets are used on valves operating below 32° F. Other packing, with grease seal and lubricator assembly, is used only where service conditions prohibit the tetrafluoroethylene resin. Bellows-sealed stuffingboxes are used for special applications or toxic fluids.

Operators. Pneumatic operators include spring-loaded diaphragms, springless diaphragms, and cylinder operators. Spring-loaded operators are used for all applications with the following two exceptions. Springless operators are used in (1) pressure balanced applications where the process pressure is used as a feedback to oppose the pneumatic signal and (2) where a constant force is required over the full stroke of the operator. Cylinder operators are used in applications where the stroke length or stem force required exceeds that obtained with a diaphragm operator. Operators for electronic control systems are the pneumatic type used in conjunction with electro-pneumatic valve positioners.

Valve Positioners. Valve positioners are used for six cases: (1) where control valve operating or shutoff pressure drop exceeds 200 psi.; (2) on valves 6 inch and larger; (3) on valves in split-range service; (4) on valves in coking, salting, or other process deposits which would change valve operating characteristics; (5) where valve operators require pneumatic pressures different than that from the controller; and (6) for use with electronic control system as stated in the preceding paragraph. Valve positioners have bypass switches and three pressure gages indicating (1) instrument loading, (2) diaphragm pressure, and (3) air supply pressure.

Diaphragm Pressure Gages: Where a valve-positioner or valve mounted pilot is not provided, each diaphragm valve has a pressure gage to indicate diaphragm loading pressure. The gage is a 2-inch, 0-30 psig, with a ¼-inch bottom connection.

Handwheels. Top-mounted handwheels are used for local manual control and on valves that do not have process bypass valves.

APPLICATION

Sizing. Valves are sized for a wide open capacity of 150 percent of normal design flow at normal valve pressure drop. Normal pressure drop for control valves is approximately 30 to 50 percent of the total pipeline frictional drop, including the control valve.

Inner Valve. The equal percentage characteristic V-port type of inner valves are used. Special applications may require other characteristics. Single-seated valves are used if possible. Balanced or double-seated valves are used when the unbalance of single-seated valves requires oversized diaphragm operators.

Bypass Valves. Bypass valves for control valves are one nominal size smaller than control valve inner valve.

Relief Valves

Relief valves are selected in accordance with the ASME Power Boiler Code and the API-ASME Unfired Pressure Vessel Code as applicable. Relief valves, in liquid service where no vapor is present, are the low lift type and are sized for 25 percent pressure accumulation.

CONSTRUCTION

Valve Body. Valve bodies are cast steel for all services except low pressure air and water. Minimum inlet connections are 1-inch, 150 psig flanges. Bronze bodies are furnished for air and water service up to 300 psi and 400° F. Minimum valve size is ½-inch. Screwed connections are used up through 1½-inch.

Disc and Spring. Disc is a one-piece piston type held against process pressure by a spring. Disc, nozzle, guide, and guide-ring are stainless steel. Spring material is carbon steel up to 450° F and tungsten steel for higher temperatures. Spring is adjustable for popping pressures within Code allowances above and below initial set-pressure.

Bonnet and Cap. Bonnet and cap material is carbon steel unless process fluid entering bonnet on balanced safety valve requires alloy construction. The cap and bonnet are provided with lugs for wire-seal after setting valve.

Lifting Levers. Lifting levers are provided on all safety valves used on steam and air service.

Balanced Safety Valves. Multiple safety valves discharging into a common header are the balanced bellows type, to eliminate effect of back pressure on set pressure.

Rupture Discs. Rupture discs are used where relief loads, caused by fire or other unexpected sources, would greatly exceed loads from normal sources. Rupture discs are used on the inlet side of a relief or safety valve to protect the valve from extremely corrosive or polymerizing materials and also to insure against valve leakage of hazardous fluids. All rupture discs are selected in accordance with applicable codes.

Tubing and Wiring

This specification covers field tubing and wiring of instruments. Tubing and wiring of controlboards is covered in the section on "Controlboards."

Tubing and Fittings. Pneumatic tubing is ¼-inch OD polyethylene. Tubing bundles of 4, 7 or 19 tubes, with a thermo plastic outer covering, are used for field tubing runs. Where resistance to fire is a consideration, the outer covering is asbestos covered with vinyl. Each bundle includes a pair of telephone wires for sound powered telephone use. Single branch lines from the bundle tubing are made by cutting the outer cover and making the connection with an elbow-fitting. Sealing of the cut in the cover is made with suitable tape. Where large bundles fan out into several small bundles or individual tubes, the connections are made in a junctionbox. Provision is made for 25 percent spare tubes in the bundles and junction box.

Fittings are brass, finger-tight, for polyethylene tubes. For corrosive atmospheres, the fittings are covered by painting or taping with suitable materials. Fittings are stainless steel, bite-type, for stainless steel tubing.

Tubing Supports. Galvanized expanded metal troughs are used as tubing supports. No elbows, tees, or crosses are used. Where the trough changes direction or branches a suitable gap allows the transition. The tubing is unsupported over the gap.

Air Supply. Instrument air supply headers are black steel pipe. Dried instrument air is distributed through the units at 80 to 100 psig. The pressure is reduced to that required at the instrument by a local regulator. Control room instrument air is reduced in a dual regulator station supplying the whole control room. Where applicable and economical, integral-mounted air sets will be used on transmitters. Takeoffs for a group of instruments include gate-valve and combination filter-drip-well-reducing air set. A 2-inch, 0-30 psig gage is connected on the output side of the air set. Where instruments are grouped, a maximum of six instruments will be supplied by one air set.

General. Instrument electrical wiring is in accordance with the latest revision of the National Electrical Code. It conforms to NEC Class 1, Group D, Division 1 or 2 classification where required. Wiring details are given in project electrical specifications.

Installation. All signal-wiring used for measurement of control circuits is run in conduit separate from power circuits. Direct current signals used for electronic control and transmission are run in multi-conductor cables. Alternating current signals used for electronic control and transmission are run in individual two-conductor shielded wire or in separate conduits. Wiring for alarm, shutdown, or interlock circuits may be run in the same conduit with power wiring.

Sealing, Purging and Winterizing

Winterizing is used to maintain normal operation during cold weather and to prevent equipment damage. Weather conditions, at individual sites, will determine the degree of winterizing. Seals or purges are used to isolate instrument parts from corrosive or gummy fluids and from solids. Seals and purges are used also for some winterizing specifications.

SEALING AND PURGING

Sealing. The use of seals is restricted to instrument applications requiring isolation of the process fluid. The

seal fluid is immiscible with and does not react with metered fluid. The seal has volatility and viscosity characteristics that are satisfactory for both process and instrument lead conditions. Direct seals are used where the seal fluid is heavier than the metered fluid. Inverted seals are used where the seal fluid is lighter than the metered fluid.

Purging. Purges are used for certain measurements. These may include level, specific gravity, and flow. Also for isolating process fluids when seals are not applicable. Another application is purging dead-end pockets such as external float cages and rotameter extensions in dirty or salting service. The fluid used is determined by the particular problem. Liquid purges are rated for 1 to 2 GPH. Gas purges are rated for 0.7 to 1.5 SCFH. Ratings are based on ½-inch, Schedule 80 meter leads. When steam is used for purging, leads are steam traced from the meter to the purge connection. Insulation is used from the purge connection to the line or vessel. Two types of purge assemblies are used: (1) Differential pressure regulator-meter assemblies are installed for process temperatures below 200° F, provided the operating pressure is not over 200 psig. The regulator furnished with these assemblies has a bronze body. (2) Armored rotameters and a needle valve are installed for process temperatures exceeding 200° F or pressure exceeding 200 psig.

WINTERIZING

Instrument Housings. Protective houses are used for local instruments where the process fluid is in the instrument body. Houses are also used for instruments requiring regular access that are outdoors and are unprotected. Such instruments include controllers and recorders. All housings are of galvanized sheet metal construction with hinged doors and a steam or electric heating coil. Blank metal doors are furnished for blind transmitters. A glass window is furnished in the door on houses for indicating transmitters and meters. The housings for analyzer transmitters are furnished as part of the instrument assembly.

The following local-mounted instruments are not housed in cabinets: (1) alarm pressure switches, (2) control-pilots for control valves, (3) displacer type level instruments, (4) float-type alarm units, and (5) pressure gages. They are winterized by sealing, steam-tracing, or by a combination of both.

Rotameters. Rotameters are winterized in accordance with the requirements of the process line in which they are installed. They are housed when they are recording and when they are outdoors.

Level Instruments. An integral-heating tube for winterizing gageglasses is used. External float instruments are steam-traced for the following services: (1) steam, (2) water, (3) caustic, (4) viscous hydrocarbon with a pour point plus 10° F and above, (5) light hydrocarbon where hydrate formation is likely, and (6) hydrocarbon where water is withdrawn as a separate phase. Where a water-hydrocarbon interface exists, the lower portion of the water-leg is traced. Condensate is used as the tracing-fluid, to limit the heat input. This eliminates false reading due to vaporization of hydrocarbon.

Pressure Gages. Outdoor pressure gages are steam traced for steam, water, and caustic service. Pressure gages in fuel oil service are insulated up to the gage, but are not steam-traced. Pressure gages in other hydrocarbon services are not winterized.

Instrument Leads. Instrument leads are winterized in services where freezing or hydrate formation is likely. In general, a solution of 50 percent diethylene-glycol (DEG) and water is used as a sealing-fluid. DEG is not used in services where the temperature is above 200° F. Instead, the instrument leads are steam-traced.

Control Valves. In light hydrocarbon-vapor services, where hydrate formation is likely, the control valves and their bypass valves are steam-traced. Only the valve body is traced. Connecting piping for valves is not.

Steam-Tracing. The length of each tracer is limited to 200 feet when using 40 to 175 psig steam, and 600 feet when using 600 pound superheated steam. For steam-tracing instrument lead lines, valves, instruments, etc.; ⅜-inch OD annealed copper tubing is used with brass fittings. Steel tubing is not used for any applications. Tracer tubing is bound to steam-traced pipe with 16 gage copper wire loops spaced on approximately 12-inch centers. Steam-traced instrument leads, instruments, lines, valves, and flanges are insulated. The item traced and its tracer are enclosed in a common insulation. Each instrument is traced independently of other instruments and process lines except for line mounted items as control valves and rotameters. Each tracer is individually trapped and valved. The heating medium for heating the tracer for heavy oil lines is 100 to 600 psig steam. For light pressure gas lines, water, hydrocarbon, and other services, 40 pound steam is used.

About the Author

W. E. Bushnell is head of systems engineering for Allis-Chalmers Manufacturing Co.'s Atomic Energy Division, Washington, D. C. He supervises the Controls, Mechanism and Electrical Engineering Groups. Bushnell has a B.S. degree in mechanical engineering from the University of Missouri, and studied business administration at UCLA. He has 16 years of instrument experience in all phases of instrumentation including operating-plant instrument maintenance, construction, and engineering. Bushnell has been with Pittsburgh Plate Glass Co., Blaw-Knox Co., C F Braun & Co., and Kaiser Engineers.

ACKNOWLEDGMENT

The author wishes to acknowledge the capable and willing cooperation of W. C. Gardner of C F Braun & Company and Dr. G. M. Fekula of Kaiser Engineers for reviewing this article.

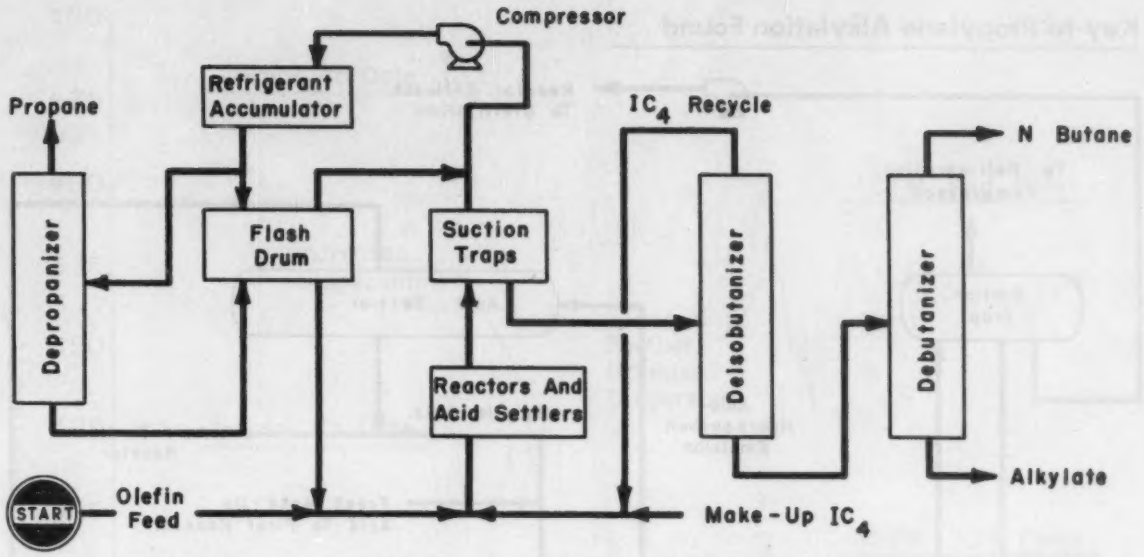

FIGURE 1—The sulfuric acid consumption has been reduced to less than 0.7 pounds of acid per gallon of total alkylate.

Key to Propylene Alkylation Found

Mobil Oil Company increases the oil-acid dispersion in the alkylation reactors to achieve improved product quality. Results permit the use of more propylene without giving high acid consumption

W. S. Knoble and F. E. Hebert
Mobil Oil Company, Beaumont, Texas

HIGH ACID CONSUMPTION has always shaded the economic picture of commercial propylene alkylation with sulfuric acid catalyst. By increasing the dispersion of oil in the acid at its Beaumont alkylation unit, Mobil Oil Company has:

- Decreased sulfuric acid consumption from 1.85 to less than 0.7 pounds per gallon of total alkylate
- Increased research leaded octane by 1.5 numbers
- Decreased total alkylate end point by more than 30° F.

This improvement was obtained on olefin feeds containing propylene concentrations of 65-85 percent in mixture with butylenes. Feeds with propylene concentrations exceeding 95 percent have been alkylated with equally satisfactory results.

General Description of Unit. The unit is of conventional design[1,2] consisting of a reactor section, a refrigeration system with depropanizer, a deisobutanizer, and a debutanizer as shown in Figure 1. The olefin charge is fed in parallel to five horizontal reactors, each with its own suction trap and acid settler, Figure 2. Makeup sulfuric acid flows to the reactors in series. Each reactor is fitted with a tube bundle, an emulsion circulation tube and an axial flow impeller. The impeller circulates approximately 50,000 gpm of the acid hydrocarbon emulsion. This large circulating stream provides turbulance, dispersion, and mixing of the acid and hydrocarbon phases.

The hydrocarbon feed and recycle acid streams are introduced at the suction of the impeller and are dispersed in the large circulating mass. After passing through the annular space between the circulation tube and the reactor shell, the circulating emulsion passes over the tube bundle before returning to the impeller to repeat the cycle.

The hydrocarbon effluent from the acid settler joins a liquid stream from the suction trap and flows through the tube bundle to remove the heat of reaction.

Initial Operation. The unit came on stream in June 1958, using 100

Key to Propylene Alkylation Found . . .

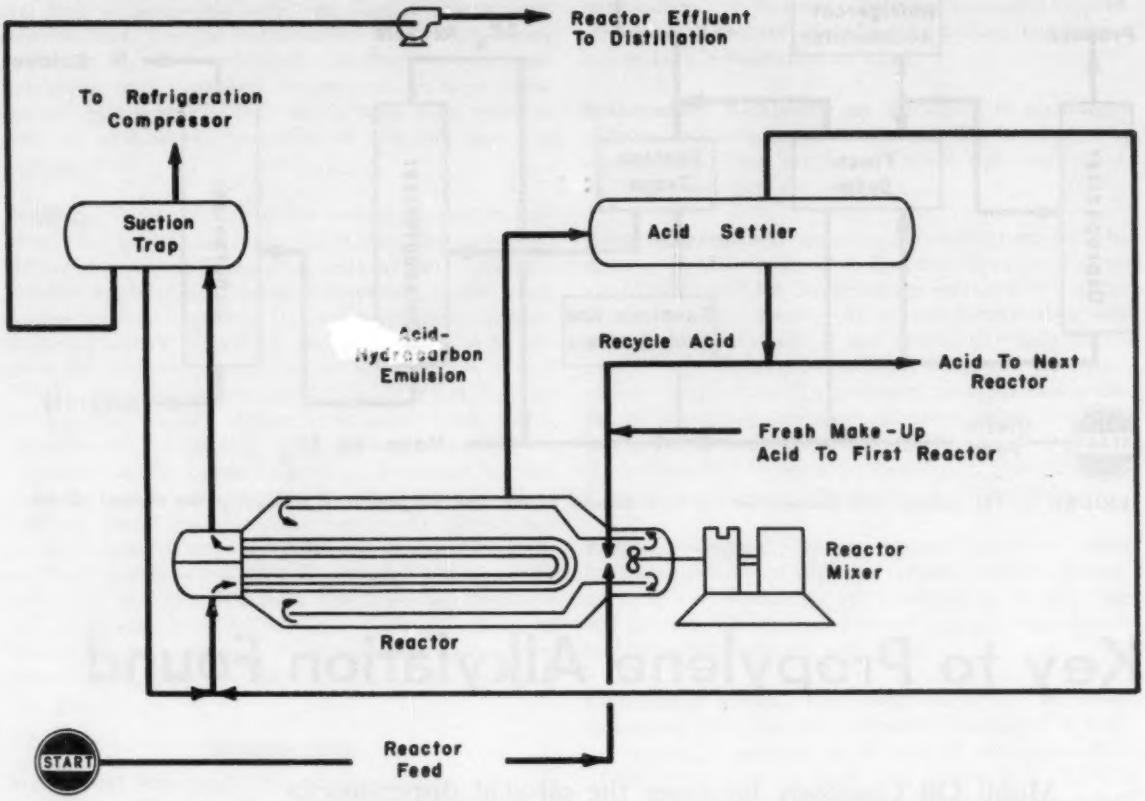

FIGURE 2—The olefin charge is fed in parallel to five horizontal reactors, each with its own suction trap and acid settler.

percent propylene for startup. Rapid fresh acid depletion (99.5 to 82.5 percent during the first 30 hours of operation) indicated that this feed composition was impractical. Butylenes were then introduced into the feed to give a propylene-butylene ratio of 65/35. This feed was maintained for the first six and a half months of operation. Attempts to increase the percentage propylene above 65 percent resulted in total alkylate end points above 440° F, F-1 + 3cc octane numbers below 100.5, and acid consumption exceeding 2.0 ppg.

Table 1 summarizes initial operations. During this period, reactor impeller speeds of 510-540 rpm were maintained. Other operational variables, that are generally accepted to have a marked effect on alkylate quality, were investigated over as wide a range as possible. For example, the external isobutane to olefin ratio was varied from 8:1 to 15:1, the acid spending strength from 96 to 85 wt. percent H_2SO_4, the reactor temperature from 40-65° F, the reactor impeller speed from 510 to 620 rpm, and the propylene in the olefin feed from 50 to 70 percent. The latter was the only variable that had any apparent effect on alkylate quality or acid consumption.

TABLE 1—Summary of Initial Operations

	Design	June	July	Aug.	Sept.	Oct.	Nov.	Average June-Nov.
Operating Conditions								
Propylenes in Olefins, Vol %	85	64	62	54	61	58	61	60
Isobutane to Olefin Ratio, Vol:Vol	9.2:1	11.9:1	9.9:1	10.5:1	10.1:1	10.1:1	10.3:1	10.5:1
Reactor Temperature, °F	53	50	48	49	56	51	45	50
Acid in Reactor Emulsion, Vol %	45	57	57	56	55	55	55	56
Strength of Spent Acid Wt. % H_2SO_4	90	90.7	90.5	90.0	89.5	90.7	91.3	90.5
Laboratory Tests on Debutanized Total Alkylate								
90% Distillation Point	....	318	328	310	314	324	324	320
End Point	Under 400	430	435	421	424	428	432	428
Octane Number, Research Clear	91.5	88.5	88.8	90.3	89.3	89.2	88.9	89.1
Octane Number, Research +3cc TEL	....	101.2	101.0	102.7	101.0	101.4	100.9	101.4
Acid Consumption, Pounds Acid per Gallon Debutanized Total Alky	1.05	1.95	1.75	1.16	2.09	1.86	1.80	1.85

Improved Operation. The final change made during this initial period of operation was to increase the reactor impeller speed to 620 rpm while maintaining 50-55 volume percent acid in the emulsion. When this proved to be ineffective, the percent acid in the emulsion was slowly increased until an emulsion cuff appeared in the acid settler. The cuff indicates the formation of a more dispersed emulsion as evidenced by the increased time required to settle the acid from the oil. Within 24 hours, the ASTM distillation end point of the total alkylate dropped 30° F, the Research leaded octane

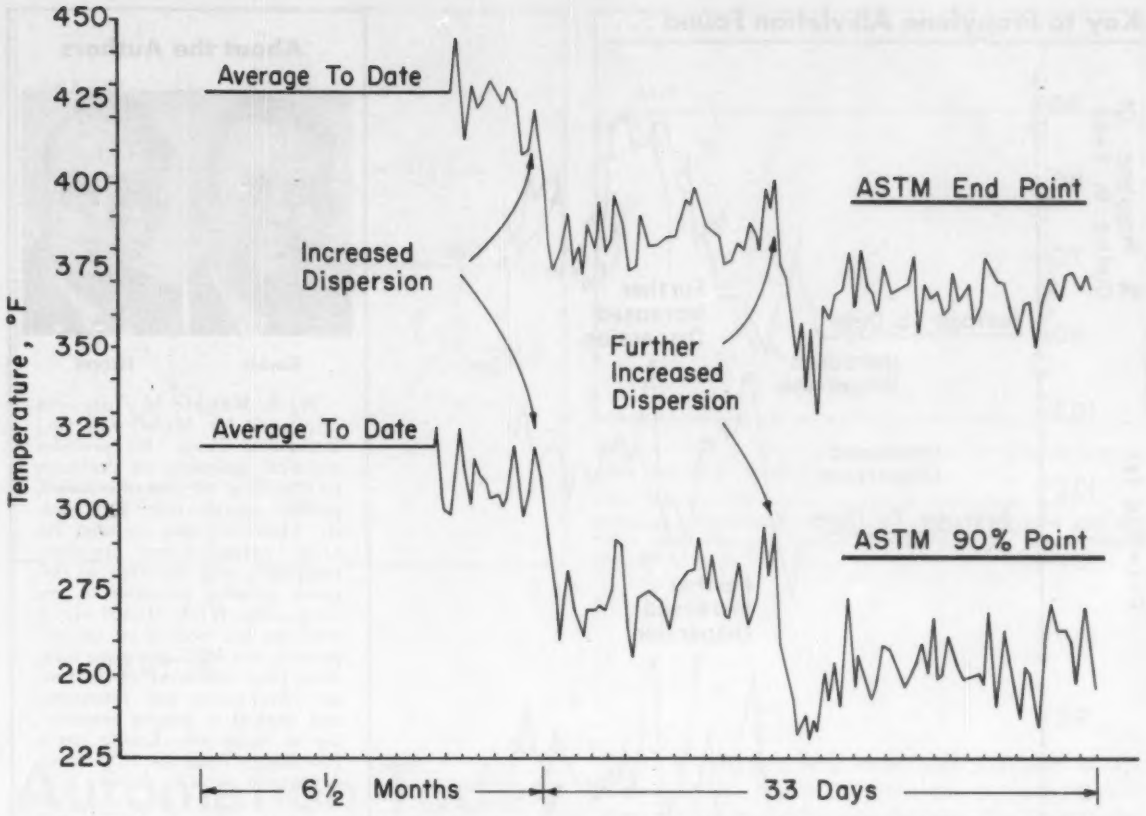

FIGURE 3—Greater dispersion of the oil-acid mixture caused a 30° F decrease in the end point of the total alkylate.

number jumped 1.5 numbers, and acid consumption dropped from 1.85 to 0.7 ppg. This improvement is shown in Figures 3 and 4. Also shown in Figure 4 is the percent propylene in the olefin feed, since it is the prime process variable controlling the octane ratings. Following the initial improvement, the percentage propylene in the feed was increased.

After several weeks, the degree of dispersion was further increased to the limit of both the available turbine horsepower and the available acid settling capacity. This was accomplished by further increasing the percent acid in the emulsion, i.e., increasing the acid recycle rate from the settler to the reactor while maintaining the maximum reactor turbine speed. The resulting reactor conditions were 65 percent acid in the emulsion and 620 rpm on the impeller. Figure 3 clearly demonstrates the further improvement in alkylate quality. Figure 4, though it shows an improvement with the increased mixing, is affected by other variables, i.e., it shows a decrease in the percentage propylene in the feed after averaging about 87 percent.

This plot does not reflect replacement of about 15 percent of the propylene with amylenes; the percentage butylene remained constant. The amylenes apparently produce an alkylate of about equal octane number as that obtained from propylene.

In effect, there are three general periods of operation: Period I, poor operation representing the first six and a half months stream time; Period II, in which a slight emulsion cuff was maintained in the acid settler; and Period III, during which the reactors were operated to the extent of two physical limits, the available turbine horsepower and the available settling capacity. Table 2 shows the average unit conditions and average product qualities for these three periods.

The data presented thus far represents unit operation at approximately 70 percent of the design alkylate production. The propylene to butylene ratio in the feed was also less than design. Since this operation, however, there have been periods when enough olefin feed was available to run design conditions. A typical week's operation at near design conditions and a typical month's operation with feeds of 97 percent propylene are summarized in Table 3.

Conclusions. This study leads to the following conclusions:

- Olefin feeds with proylene con-

TABLE 2—Average Operating Conditions and Product Tests

	Period I	Period II	Period III
Total Alkylate Rate, BPSD	6,000	5,200	5,700
% C_3= of Total Olefins	60	74	79
Min % C_3=	.....	62	72
Max % C_3=	.....	89	89
External Isobutane/ Olefin Ratio	10.5	11.9	11.7
Laboratory Test on Total Alkylate			
ASTM 90% Point	320	272	250
ASTM End Point	428	384	363
F-1 Clear	89.1	90.9	91.5
F-1 +3cc TEL	101.4	102.4	102.6
Acid Consumption, PPG (98.5-90%)	1.85	0.691	0.659

Key to Propylene Alkylation Found . . .

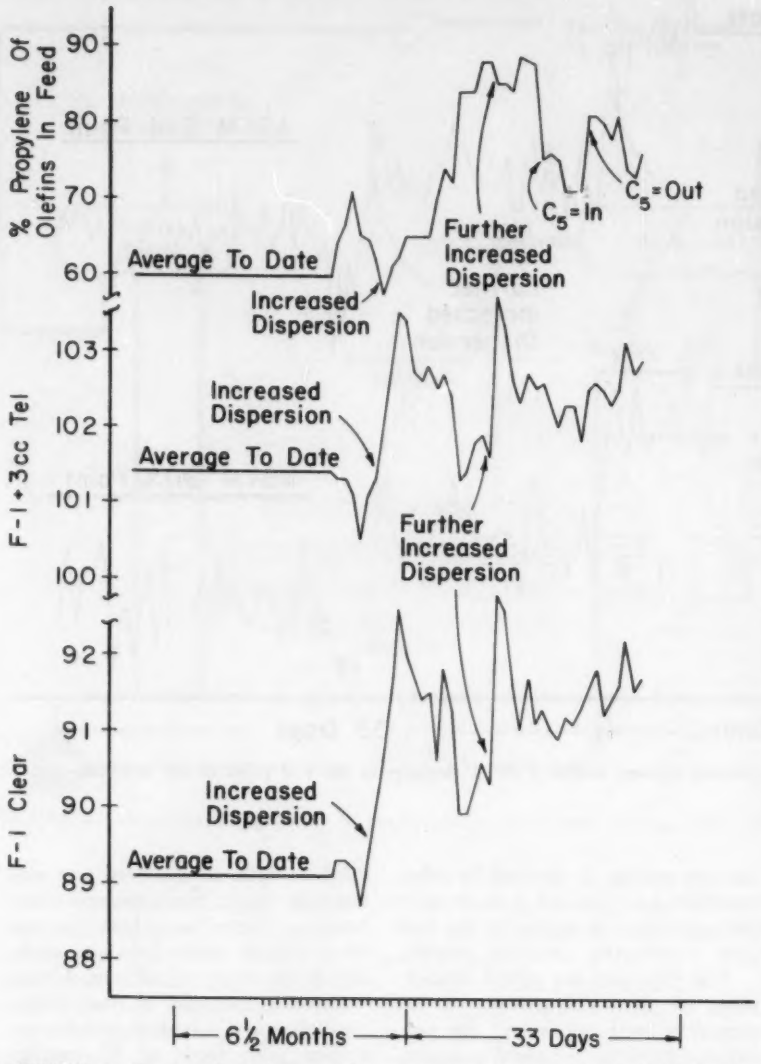

FIGURE 4—Greater dispersion permits more propylene to be included in the olefin feed.

centrations exceeding 95 percent can be alkylated using sulfuric acid with the following favorable results:

Octane number of total alkylate, F-1 + 3cc TEL 101.5

End point of total alkylate, °F 380

Acid consumption, lbs./gallon 1.1

TABLE 3—Process Comparison

	Near Design Conditions	High Propylene Feed
Operating Conditions		
TotalAlkylate, B/D	7500-8000	7000
% Propylene in Olefins	85-90	97
Reactor Temp., °F	45-50	45-50
External I/O	9.1	11.5
Laboratory Tests on Total Alkylate		
90% Point	287	277
End Point	395	382
F-1 Clear Octane No.	89.4	89.1
F-1+3cc Octane No.	101.6	101.4
Acid Consumption, PPG (98.5—90.0%) H_2SO_4	0.89	1.10

• The key to sucessful alkylation of propylene is a highly dispersed reator emulsion, which results primarily from the control of two variables —the degree of mixing and the percentage acid in the reactor.

• Other operating conditions necessary for alkylating propylene are similar to those for butylene; for example, reactor temperature of 45-50° F, isobutane to olefin ratio of 6-10:1, and acid spending strength of approximately 90 percent.

• Contactor design for propylene alkylation requires greater horsepower for mixing than is required for butylene alkylation.

Patents. Certain operating techniques described in this article originated with Mobil Oil Company and are the subject matter of application for patents.

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W. S. Knoble is a process engineer for Mobil Oil Co., Beaumont, Texas. He provides technical assistance on problems pertaining to unit operations, product specifications and quality, blending and treating. He also evaluates new processes, equipment and materials to improve existing processes or reduce costs. With Mobil since 1953, he has worked on the expansion of a MEK dewaxing unit, done pilot unit work on reformate extraction and reforming, and worked in process engineering on many jobs. Knoble has a B.S. degree from the U.S. Naval Academy.

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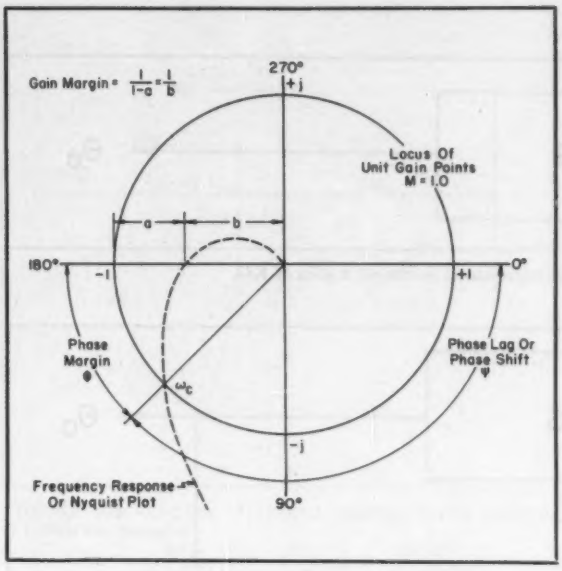
[2] Putney, D. H. and O. J. Webb, PETROLEUM REFINER, Vol. 32, No. 9 (September, 1953), p. 104.



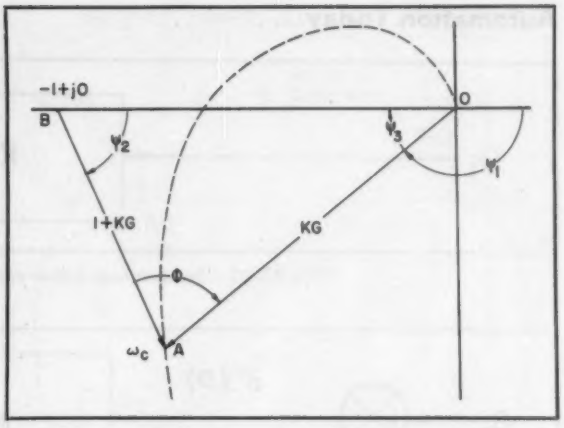


FIGURE 96—A closed loop response can be derived from an open loop Nyquist diagram.

FIGURE 95—The phase margin is determined (left) by the point of intersection between the frequency response plot and unity gain. The gain margin is defined by the intersection of the plot with the 180° line.

PART 16

Automation Today

Here is a continuation of the discussion on Nyquist diagrams. It will show how an inverse Nyquist diagram sometimes can be easier and simpler to make

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St. Louis

CONTINUING the introduction of the Nyquist diagram which we began with the last part, we will also enumerate some of the advantages and disadvantages of using this method for representing the transfer functions of process equipment and their associated control elements.

PHASE AND GAIN MARGIN ON THE NYQUIST DIAGRAM

Two commonly specified criteria for indicating the degree of inherent stability of any controlled system are those of "phase margin" and "gain margin." Phase margin is the number of degrees by which the phase lag differs from 180° at the point where the system gain falls below 1.0. Gain margin is that factor by which the gain at a phase lag of 180° could be multiplied and still be less than 1.0.

Part 6 described how these were indicated on the Bode diagram. Figure 95 shows the representation of phase margin on the Nyquist diagram. The "unit circle" shown on the figure is, of course, the loci of all possible points which the system frequency response might have taken and still have a gain of 1.0. Figure 95 also diagrams the concept of gain margin. Notice that both of these measurements are quantitative indications of stability while the rule for showing stability given in Part 15 was only qualitative. Notice also that while the Nyquist plot gives a neater representation of phase margin than does the Bode diagram, the opposite is true for gain margins. The reader will recall that a commonly specified phase margin is 45° as shown on Figure 95.

OPEN AND CLOSED LOOP RESPONSES

The (— 1) point has several other very interesting uses on the Nyquist diagram beyond that of indicating stability. Figure 96 diagrams one of these.

If we represent the response of a particular system, KG, at a certain frequency, ω_c, as

$$(KG)\,\omega_c = OA \angle \psi_1, \qquad (1)$$

then a line drawn from the (— 1) point is equal to

$$(1 + KG)\omega_c = BA \angle \psi_2, \qquad (2)$$

The ratio of these two vector quantities can be written as

$$\left(\frac{KG}{1+KG}\right)\omega_c = \frac{OA \angle \psi_1}{BA \angle \psi_2} = \left|\frac{OA}{BA}\right| \angle (\psi_1 - \psi_2) = \left|\frac{OA}{BA}\right| \angle \phi \qquad (3)$$

where |OA| and |BA| are the purely numerical values

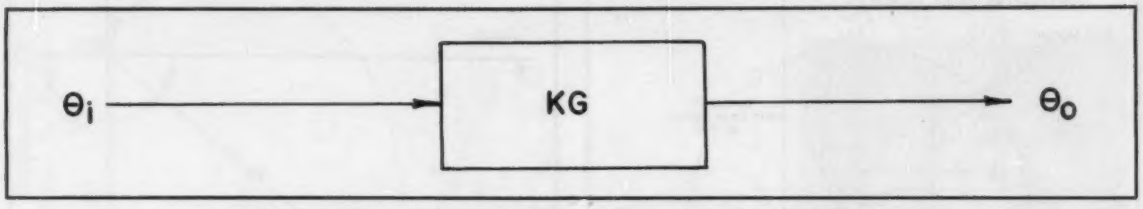

FIGURE 97—An open loop system can be represented as having a gain of KG.

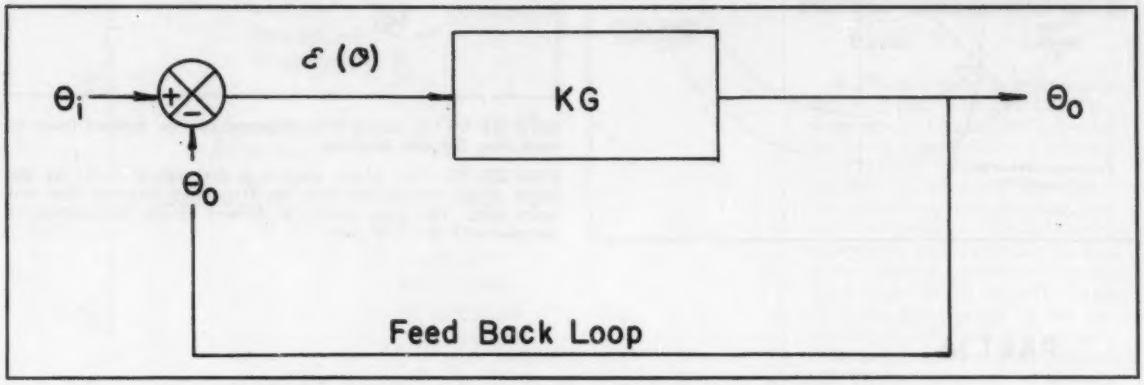

FIGURE 98—A closed loop system then can be derived by Equation (3).

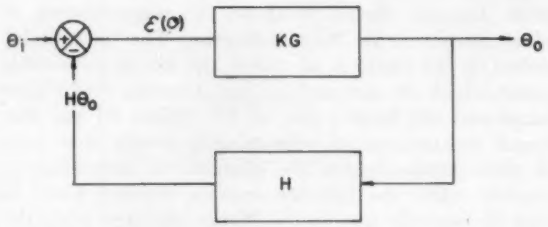

FIGURE 99—The existence of a transfer function in the feedback loop can nullify the validity of Equation (3).

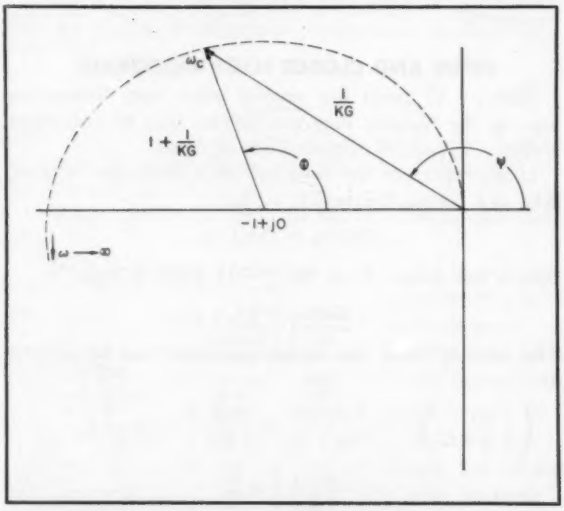

FIGURE 101—Here is the representation of open and closed loop response on the inverse Nyquist diagram.

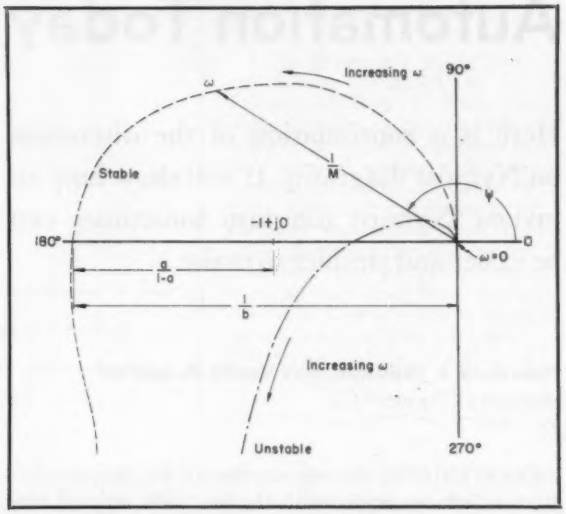

FIGURE 100—The inverse Nyquist diagram sometimes can give a simpler and easier representation of the frequency response.

of the lengths of the vectors. Since

$$\psi_2+\psi_3+\phi=180°, \text{ and } \psi_1+\psi_3=180°, \text{ then}$$

$$\psi_2+\phi=\psi_1, \text{ and } \phi=\psi_1-\psi_2 \qquad (4)$$

Now if we examine Figure 97, we see that the response of the open loop system to a disturbance, Θ_i is

$$\Theta_o=(KG)\,\Theta_i, \text{ or } \frac{\Theta_o}{\Theta_i}=KG \qquad (5)$$

In the case of the closed loop system of Figure 98

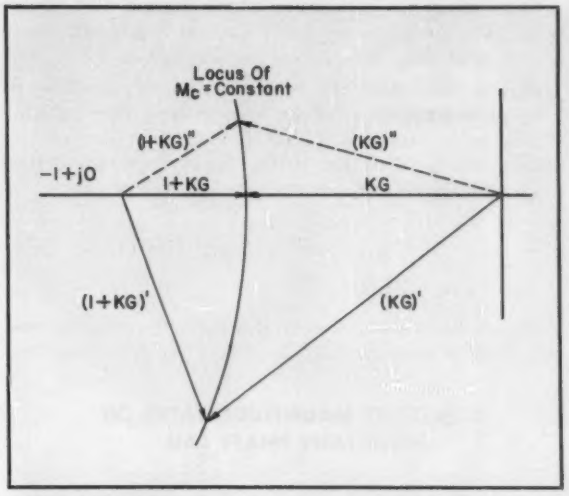

FIGURE 102—The line of constant magnitude ratio is shown. It fulfills the equation

$$M_c = \frac{KG}{1+KG} = \frac{(KG)'}{(1+KG)'} = \frac{(KG)''}{(1+KG)''}$$

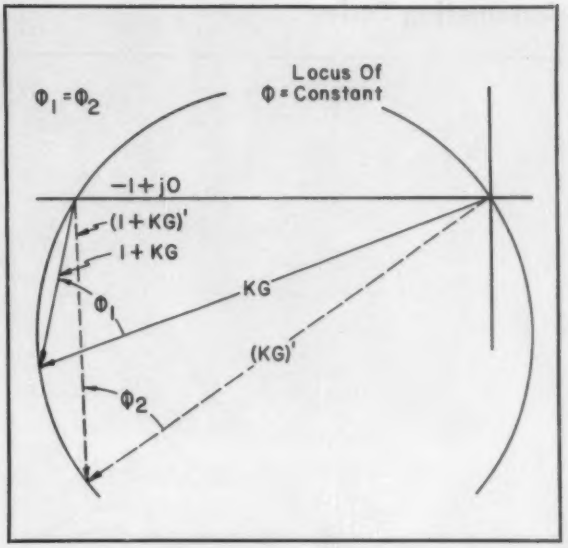

FIGURE 103—Here is the locus of constant ϕ's (i.e., $\phi_1 = \phi_2$).

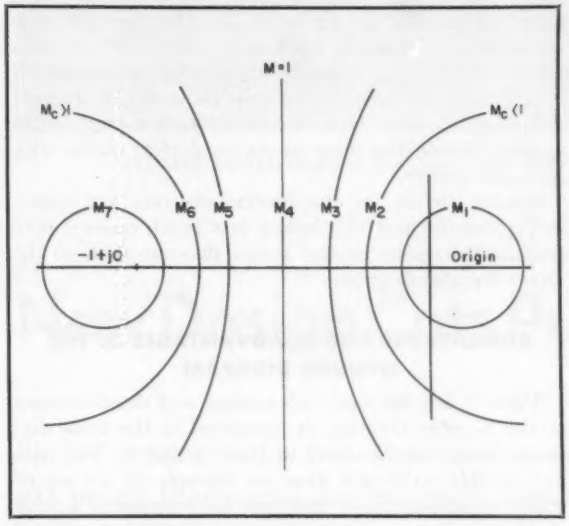

FIGURE 104—This is a family of curves where $M_1 < M_2 < M_3 \ldots$

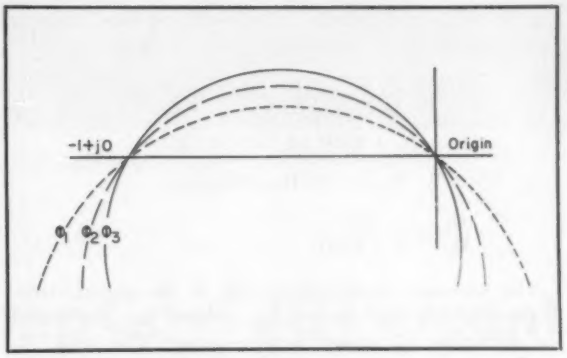

FIGURE 105—This is a family of curves where $\phi_1 < \phi_2 < \phi_3$.

however

$$\Theta_o = (KG)\left(\varepsilon(\Theta)\right) = (KG)(\Theta_i - \Theta_o)$$

$$\Theta_o + KG(\Theta_o) = KG(\Theta_i)$$

$$\Theta_o(1+KG) = KG(\Theta_i)$$

$$\frac{\Theta_o}{\Theta_i} = \frac{KG}{1+KG} \qquad (6)$$

which is the relationship evolved in Equation (3). Therefore, the ratio of the vector defining the open loop response of the system and that from the (— 1) point automatically gives the closed loop response of the system which is its response under automatic control. The reader should notice that the presence of a transfer function in the feedback loop of the closed loop case

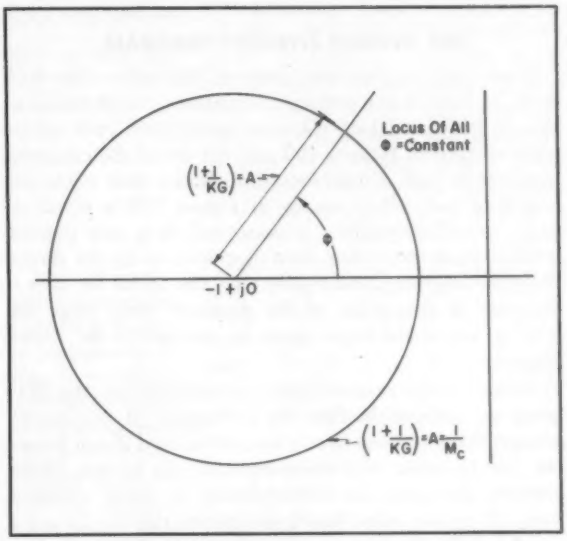

FIGURE 106—The inverse diagram of the information in Figure 102 would look like this.

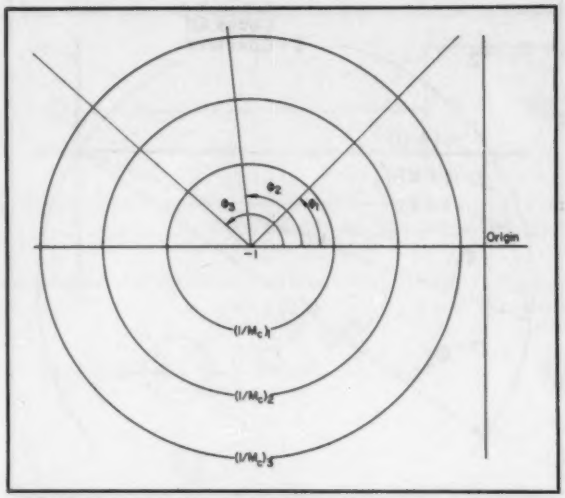

FIGURE 107—In this case it is easier to prepare an inverse diagram than a direct Nyquist diagram.

would nullify the relationship developed here. Such a case might be that shown in Figure 99. Here

$$\Theta_o = (KG)\left(\varepsilon\,(\Theta)\right) = (KG)\,(\Theta_i - H\Theta_o)$$

$$\Theta_o + KGH\,(\Theta_o) = KG\,(\Theta_i)$$

$$\Theta_o\,(1 + KGH) = KG\,(\Theta_i)$$

$$\frac{\Theta_o}{\Theta_i} = \frac{KG}{1 + KGH} \qquad (7)$$

The presence of the factor, H, in the denominator alone prohibits the use of the method just developed for obtaining the closed loop response. The term, H, might arise as the response of a sampling devise or of a signal transmission line or other such element of the control system.

THE INVERSE NYQUIST DIAGRAM

If one were to plot the inverse of KG rather than KG itself, as used in our previous discussions, the determination of the closed loop response would have been somewhat simplified. Figures 100 and 101 detail the concepts involved in such a representation. Notice that while the length of the 1/KG vector in Figure 100 is equal to 1/M, the phase angle ψ is preserved. It is now plotted counterclockwise rather than clockwise as on the direct Nyquist diagram. Notice also that the terms for $\omega \to o$ are now at the origin of the diagram while those for $\omega \to \infty$ are at the edge, again in contrast to the direct Nyquist.

However the general rules for stability on the diagram as outlined in Part 15 still apply. If one moves along the curve from $\omega = o$ to $\omega \to \infty$, and if one passes the (— 1) point with it on ones left the system whose transfer function has been plotted is stable (dashed line). If on the other hand, one passes the (— 1) point on the right, the system will be unstable just as before (dashed and dotted line on Figure 100).

Our statements concerning phase margin also apply while gain margin is represented as on Figure 100, that is, it now appears directly on the diagram as 1/b.

Figure 101 details the representation of closed loop from open loop data on the inverse Nyquist diagram. If the basic vector is $|1/KG| \angle \psi$, then the vector joining the (— 1) point to the point representing the frequency response at the frequency ω_o is equal to

$$\left|1 + \frac{1}{KG}\right| \angle \psi\,\Phi = \frac{KG + 1}{KG} = \frac{\Theta_i}{\Theta_o} \qquad (8)$$

or the inverse of Θ_o/Θ_i

This is therefore a simpler and easier to use relationship than is possible with the direct Nyquist diagram.

CONSTANT MAGNITUDE RATIO OR CONSTANT PHASE LAG

The ability of both the direct and inverse Nyquist diagrams to represent the open and closed loop functions at the same time has lead to a special use for them in control system design. This is to help determine a specific closed loop gain and phase lag by working only with the open loop function. As Figure 102 shows, there is a curve on the direct Nyquist diagram which connects all possible points which would have the same closed loop magnitude ratio and another is shown in Figure 103 which connects all possible points which would have the same closed loop phase lag, ϕ. Figures 104 and 105 show how families of such curves would appear. Notice that these curves are perfect circles with different centers.

Similar curves for the inverse diagram are shown in Figures 106 and 107. Notice how much easier it is to prepare the curves on the inverse diagram than on the direct Nyquist diagram.

ADVANTAGES AND DISADVANTAGES OF THE NYQUIST DIAGRAM

Table 1 lists the main advantages and disadvantages of the Nyquist diagram as compared to the Bode diagram which we discussed in Parts 5 and 6. The next part of this series will show an example of the use of the Nyquist diagram to represent the response of a piece of chemical processing equipment and its associated control system.

TABLE 1—The Nyquist Diagram

ADVANTAGES	DISADVANTAGES
1. Only One Curve Needed to Represent Both Magnitude Ratio and Phase Lag.	1. Asymptotic Methods For Plotting Functions Not Available.
2. Phase Margin Very Easily Represented.	2. Since Log Scales are Not Used, Modification of a Transfer Function as by a Controller Function Requires a Completely New Plot.
3. Nyquist Diagram Allows Ready Representation of Closed Loop Response From Open Loop Data.	3. Since Magnitude Ratio is Plotted Against Phase Lag, Frequency Become Only a Parameter and Its Influence on the Response Cannot Be Directly Ascertained.
4. Curves of Constant M and Constant ϕ Aid the Establishment of Optimum Controller Functions.	

TO BE CONTINUED

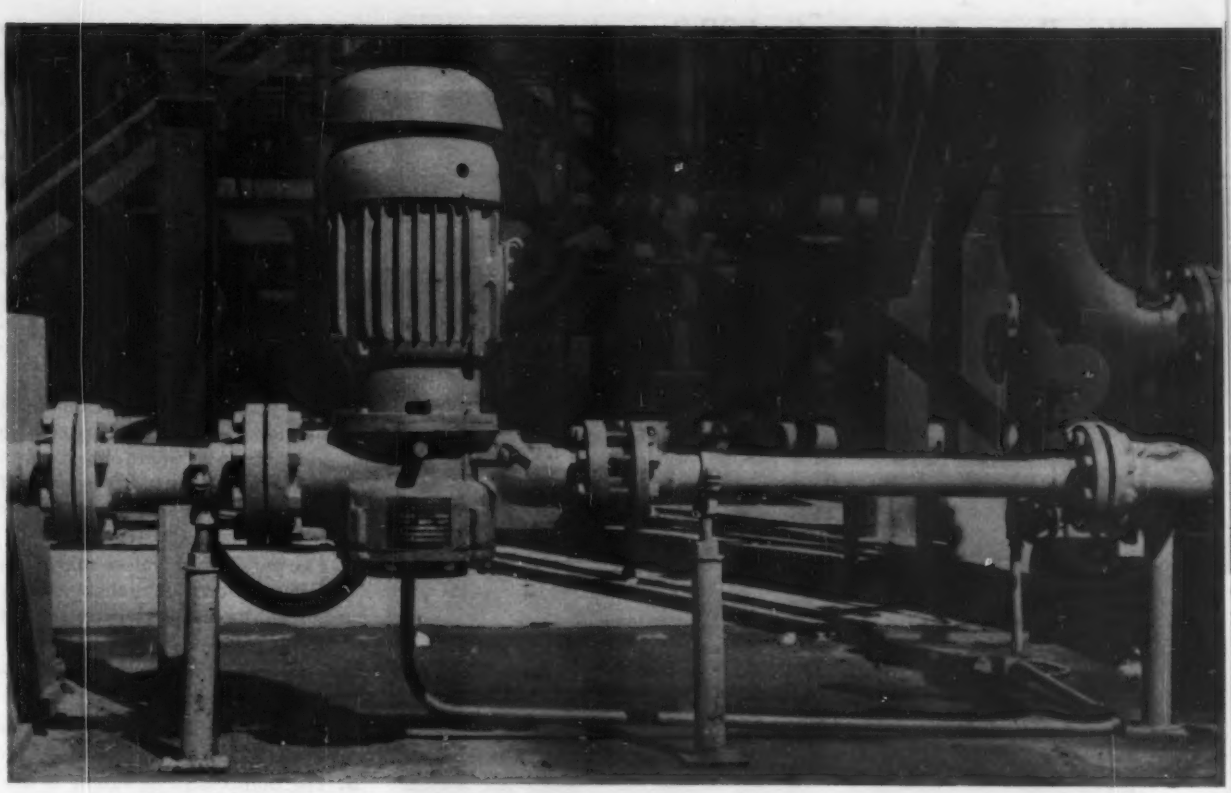

FIGURE 1—This standard pump is mounted directly in the piping run without a concrete foundation.

New Design Cuts Pump Cost 20 Percent

Shell Chemical study develops one size vertical centrifugal pump that meets performance requirements for 80 percent of plant's pumps

R. G. Jobe
Shell Chemical Company, Houston

IN THESE TIMES of rising costs and narrowing profit margins, we are all seeking methods for reducing equipment costs. The economic advantages of standardizing the design of widely used mechanical equipment have long been recognized and the successful applications of such programs are numerous. Since the centrifugal pump is one of the most widely used items of equipment in the chemical industry, considerable incentive exists for standardizing this equipment and, in fact, an industry-wide standardization program is in progress. In considering the adoption of a standard pump for Shell's Houston plant, a study was made covering approximately 650 plant-wide centrifugal pump installations to determine the range of head and capacity requirements and to obtain cost data to serve as the basis for selecting the optimum standard design.

Performance Requirements. To establish the range of head and capacity required to serve the plant, design points for all existing pumps were plotted on one head-capacity chart for comparison. Analysis of the distribution of these points led to the conclusion that the standard pump should be capable of developing a shut-off head of at least 200 feet and a differential head of 120 feet at a capacity of 250 gpm. The data indicated that a pump meeting these requirements would handle approximately 80 percent of the centrifugal pump applications in our plant. In order to have a compact pump practical for lower capacity applications, it was decided that performance beyond these limits should be handled by a larger pump.

Economic Requirements. The basic economic consideration guiding

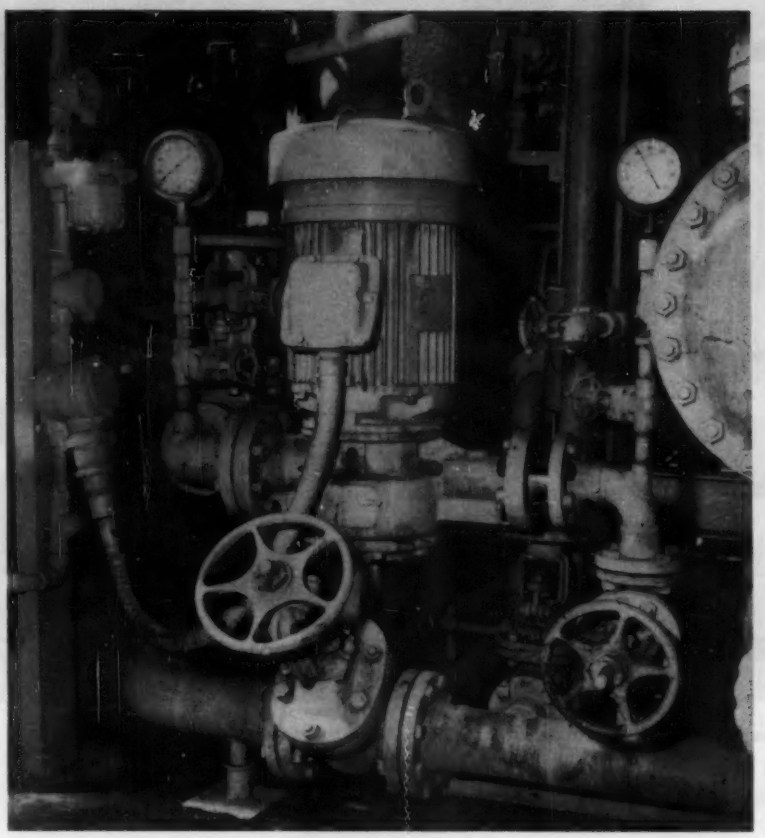

FIGURE 2—This standard pump is installed in a congested process area. Note the plug-in type electric power and grounding connection.

the selection of a standard pump was that it should result in the lowest over-all cost for the life of the pump. In other words, Shell was seeking a unit which would provide an economic balance between the first cost of purchase and installation and the continuing cost of operation and maintenance.

Comparison of continuing costs with capital cost showed that on the average, during the life of the pump, the sum of the continuing costs (maintenance, power, oil, etc.) would exceed the capital cost by several hundred percent. This indicated that the standard design should emphasize reduction of the continuing costs. This does not mean that capital costs were to be disregarded but rather that maintenance cost reduction features would be favored in cases where compromises would be required.

Further analysis showed that maintenance costs were one of the most important factors contributing to the continuing costs. In view of this fact, it was apparent that maintenance cost reduction should be one of the primary objectives of this standardization program. Further study of maintenance costs led to the conclusion that (1) the standard pump should be designed so that it could be quickly removed from service for shop repairs that (2) the pump should be simple to dismantle and reassemble in the shop and that (3) the pump should be designed to use a minimum number of component parts. It should be noted here that because of the relatively small size of the plant's pumps and the unfavorable conditions in the field, it is Shell's practice to make repairs in the shop; hence, the installation and removal steps are an integral part of the maintenance procedure. Ease of dismantling under shop conditions and the reduction in the number of parts are features which would be expected to reduce cost of repair parts and further reduce maintenance labor costs. All features of the standard pump were expected to be consistent with the basic requirements of dimensional interchangeability, reliability, and moderate first cost.

Design Criteria. Evaluation of the over-all economics and performance requirements resulted in establishing the following criteria for the selection of a standard pump for the plant:

1. The pump should be capable of providing sufficient capacity to meet the performance requirements for at least 80 percent of the centrifugal pumps in the plant.
2. The pump must feature maximum dimensional interchangeability both in mounting dimensions and pump parts.
3. The pump must be simple to remove and install.
4. The pump should use a minimum number of parts.
5. The pump must be simple to dismantle and repair under shop conditions.
6. The installed cost of the pump should be as low as possible, consistent with maintenance requirements and reliability.

Pump Description. The pump which evolved is shown in Figure 1. Basically, it is a vertical centrifugal pump with an integral electric drive. Here the pump is mounted in a piping run. The pump case is designed to withstand piping stresses so that the pump may be installed without a baseplate or concrete foundation.

Figure 2 shows another of the standard pumps installed in a congested process area. Here again, the pump is supported by the piping and no foundation is used. Since the drivers are integral with the pumps, all of the standard units are equipped with a plug-type electric power and grounding connection to facilitate quick removal. A safety interlock is provided to turn off the power in case the plug is removed when the circuit is "hot." All motors use three phase electric power and are connected in the shop so as to have a standard phase rotation. All outlets are corrected to this phasing as they are installed, so that replacement pumps will always rotate in proper

direction without the need for field checks. The plug-type connection, the vertical design, and the heavy duty case are all features which were incorporated to meet the requirement for quick removal and installation.

The seven major parts of the pump are shown in the sectional drawing, Figure 3. These are the case, the cover, the impeller, the shaft, the mechanical seal, the sleeve, and the orifice. All similar parts are dimensionally interchangeable between pumps. A common shaft is used for both pump and motor. The shaft is protected from the process fluid by the impeller, the impeller nut, and the sleeve. This protection permits interchangeability of drivers between alloy and carbon steel pumps. Because of the extended shaft, these drivers are not interchangeable with standard vertical motors; however, the cost is comparable to that of horizontal motors of the same classification. Since the pump was designed for use under shop rather than field repair procedures, the advantages of close coupled design could be realized without increasing maintenance costs because of limited accessibility.

The close coupled design results in reducing the number of parts and improves ease of dismantling by eliminating the pump bearing, the bearing bracket, the lubricator, the shaft coupling, and the coupling guard, all of which are found on the conventional horizontal pump. In addition, the integral design results in a more rigid shaft than would be possible for a coupled shaft design of the same diameter. This permits the use of a smaller mechanical seal than for a comparable horizontal unit.

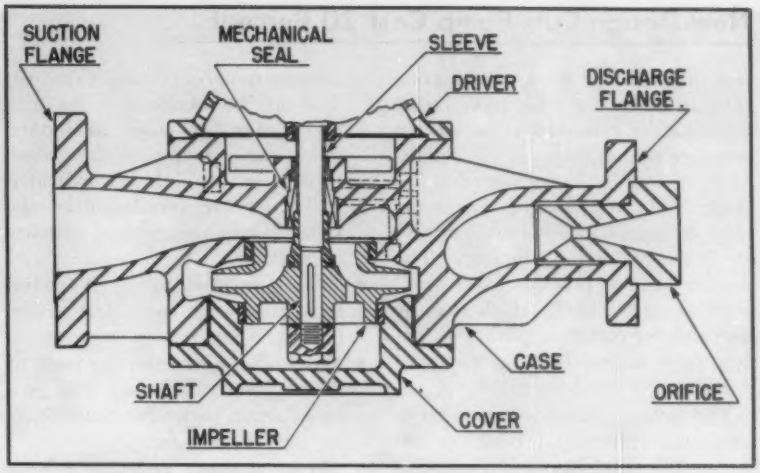

FIGURE 3—Section drawing showing seven major pump parts.

Since alloy construction is sometimes required for pumps in chemical plant service, this pump was designed for ease of casting so that it could be economically built in any castable alloy; and as mentioned previously, the shaft is fully protected by the wetted parts so that special motors with alloy shafts will not be required for alloy pumps.

Pump Performance. The pump uses a plug-type discharge orifice to modify the performance of the basic unit. The orifice serves to eliminate the need for providing oversize drivers for lower capacity applications and to modify the head-capacity relationship at lower flow rates. Its effect is illustrated by the curves on Figure 4. The upper curve represents the maximum available head. For full protection to the end of the curve, a 25 horsepower driver would be required. A one inch diameter orifice limits the power requirements to 20 horsepower and a ¾-inch diameter orifice will limit the power requirement to 15 horsepower. For smaller impeller diameters, the power requirements can be limited to 3 horsepower. As with other centrifugal pumps, the efficiency drops off at lower flow rates. Low rate efficiencies can be improved through the selection of appropriate impeller patterns. Since our electric power costs are relatively low (0.7¢/kwh), we have been able to economically standardize upon one impeller pattern in order to minimize the number of different spare parts.

The effect of impeller diameter and orifice bore upon head and capacity performance characteristics is shown in Figure 5. The pump is not limited to the curves shown. Intermediate impeller diameters or orifice bores may be used. Any performance point within the maximum capabilities can be approached by trimming the impeller, by reducing the ori-

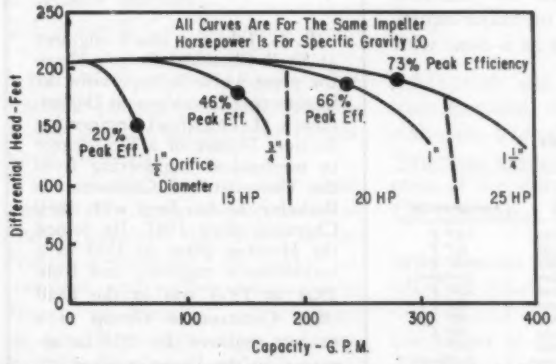

FIGURE 4—Effect of orifice on pump performance. Smaller diameter impellers require less power.

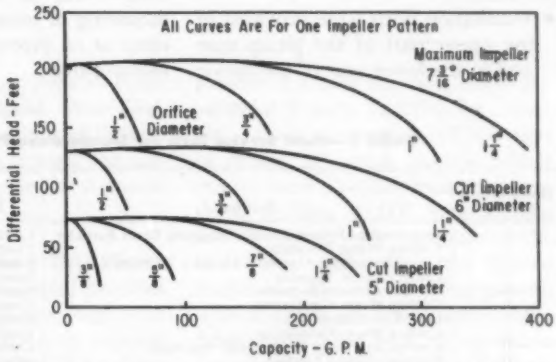

FIGURE 5—Curves show combined effect of varying impeller diameter and orifice bore.

fice diameter, or by a combination of both methods. The particular combination selected depends on whether the objective is (1) limitation of maximum power requirement, (2) to obtain a particular slope of head capacity curve, or (3) to obtain maximum efficiency. The smaller orifices provide "steeper" head capacity curves which may be desirable for certain applications. Efficiency is higher for a given point if a larger orifice bore is used.

The actual pump will provide a maximum differential head of 206 feet at 125 gpm. Maximum capacity is approximately 390 gpm at 135 feet differential head. NPSH requirements vary from 4 feet at 50 gpm to 19 feet at 390 gpm. On this basis, the pump meets the original requirement to cover approximately 80 percent of our centrifugal pump applications.

Field Experience. The prototype was performance tested at the factory during the latter part of 1957, and was installed in the plant for service tests in January 1958. Ten additional pumps were installed during the following eight months. For test purposes, a cross section of plant services was selected as shown in Table 1.

Early experience in process services showed that the motor was vulnerable to damage from vapors and liquids which leaked past the pump seal. Before design changes were made, a series of lower bearing failures was experienced, and in three instances the insulation on the motor windings failed due to chemical attack. The following design changes were made in order to eliminate this problem:

- Ventilation ports were provided in the upper part of the pump case and in the lower part of the motor housing to permit vapors to escape. The case was enclosed, in the original design, in order to confine fluid leakage to the drainage ports. However, experience indicated that adequate ventilation of the upper pump case was of primary importance.
- Tetrafluoroethylene resin sealed bearings were installed in the motor.
- A drainage port from the back of the stationary seal face was provided as an outlet for fluids leaking past the seal faces.

These features appear to have eliminated motor failures.

Costs. Although the new design has only recently emerged from the development stage and it will be several years before it can be fully evaluated, some indications as to the effect of the design on plant pump costs have resulted from Shell's field experience. Comparison of the installed costs for the eleven test units with similar costs for conventional medium duty horizontal centrifugal pumps in these services shows that installed costs (including the price of the pump) were reduced 20 percent to 35 percent below that of conventional pumps of cast steel construction. These savings are due largely to the elimination of concrete foundations and the elimination of the shaft coupling with its attendant alignment problems. In the congested process areas of existing plants, the compact design permits the standard pump to be installed without undue extension of piping or blocking of accessibility to existing equipment. In new construction, further savings especially in piping costs could be made by judicious mounting of pumps on major equipment or on pipeways as is done with motor valves.

Maintenance. The pump has shown no tendency to require undue maintenance. During the six months period since January 1, 1959 there was only one failure experienced out of 16 pumps in operation during that period. This was a mechanical seal failure caused by the presence of abrasive particles. The pump was reinstalled with a set of tungsten carbide faces and it has been operating satisfactorily since that time.

Field experience indicates that labor requirements to remove and reinstall the new pump are about 25 percent of that required for horizontal units. Because they can be quickly removed and installed, Shell has purchased several complete standard pumps to be kept in stock for use as replacements when maintenance is required on the standard units installed in the plant. We believe that his will improve maintenance efficiency by reducing the amount of emergency repair work presently required on critical units. Although a service time of only one year has been available to establish comparative maintenance costs, experience to date shows the maintenance cost to be 15 to 25 percent less than that for comparable horizontal pumps.

(Originally presented before the ASME annual meeting, Atlantic City, Nov. 29-Dec. 4, 1959).

TABLE 1—Plant Service Tests for Standardized Pumps

Installation Number	Service	Duty	Temperature
1	Intermediate Process Fluid Containing Resin Particles	Continuous	150° F
2	Cooling Water Circulation	Continuous	60° F
3	Liquid Petroleum Gas with Abrasive Particles	Continuous	100° F
4	Crude Alcohol Transfer	Intermittent	Ambient
5	Acetone Column Bottoms	Continuous	225° F
6	Cooling Water Circulation	Continuous	60° F
7	Liquid Petroleum Gas	Continuous	100° F
8	Cooling Water Circulation	Continuous	60° F
9	Lower Layer from Resin Phase Separator	Continuous	180° F
10	Epichlorohydrin Loading	Intermittent	Ambient
11	Allyl Chloride Loading	Intermittent	Ambient

About the Author

R. G. Jobe is a senior engineer at Shell Chemical Corp.'s Houston plant where he supervises the Engineering Development Department's Mechanical Engineering Section. Holder of a B.S. degree in mechanical engineering from the University of California at Berkeley, he has been with Shell Chemical since 1947. He joined the Houston plant in 1953 as a maintenance engineer, and from 1954 to 1956 was in the head office Construction Group as a project engineer. In 1956 he returned to the Houston plant.

FIGURE 1—France's first synthetic rubber plant will produce 20,000 tons per year of butyl rubber.

How and Why Butyl Moved to Europe

Here are the economics, the design and construction of France's first synthetic rubber plant

J. Albert Curran
C F Braun & Co., Alhambra, Calif.

IN APRIL of 1959, France's first synthetic-rubber plant started producing the first butyl rubber outside North America.

The realization of this plant, greatly affecting the economy of France, involved the efforts of the French government, the major oil, chemical, and rubber companies of France, an American oil company, an American engineering and construction firm, and one Italian engineering and construction firm.

Materials and equipment came from England, Scotland, West Germany, the United States, and France. American operators formed the nucleus of the start-up team. A minor UN operation.

Why France Wanted This Plant. Most of France's financial troubles after World War II stemmed from her excess of imports over exports. This situation caused a shortage of foreign currencies, especially dollars. Rubber is one of the most costly imports for France. In 1956, for example, France consumed 169,000 tons of rubber, of which natural rubber comprised 136,000 tons and synthetic rubber 33,000 tons. Dollars left the country for purchase of the synthetic rubber from the United States and Canada. Sterling pounds were spent to get the natural rubber from Asia. This type of operation contributed to the drain on France's economy.

How and Why Butyl Moved to Europe . . .

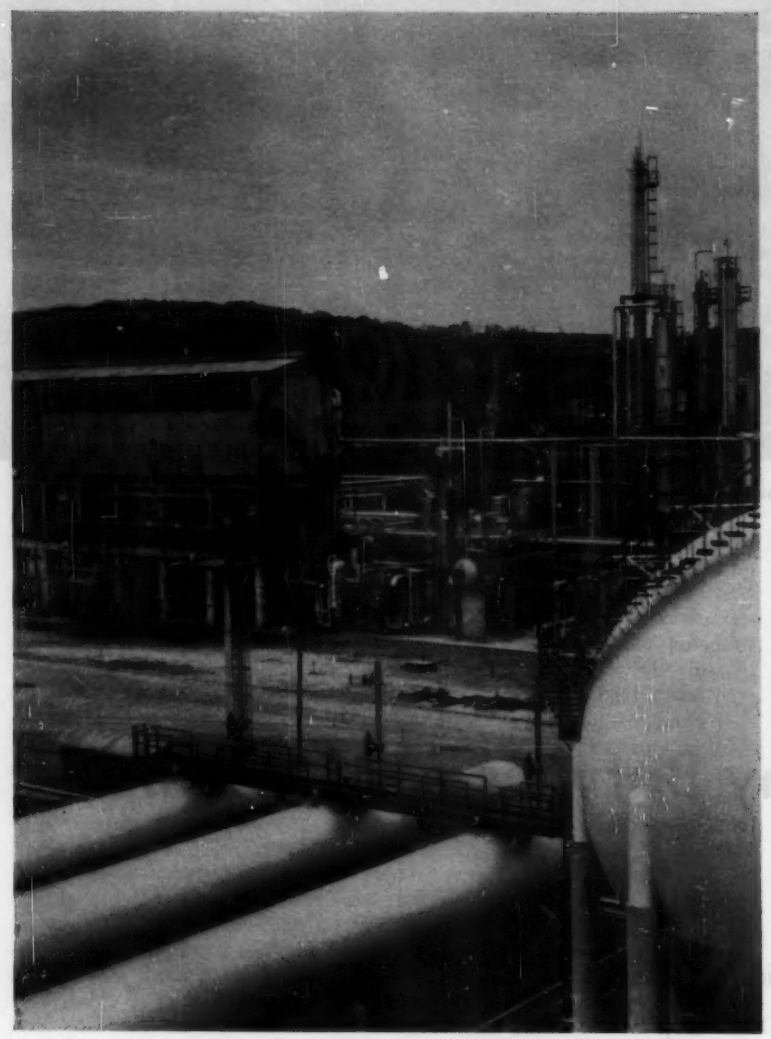

FIGURE 2—Shows the reactor building in which isobutylene and isoprene are copolymerized at —140° F.

France saw that the post-war boom in Western Europe indicated an increased future need for rubber. Natural rubber accounted for some 88 percent of Western European rubber consumption, as compared to one-third of United States consumption. The predominant position of natural rubber over synthetic in Western Europe would have to give way to the increasing needs.

In 1956, France estimated that her consumption of rubber would increase from about 170,000 tons in 1956 to about 215,000 tons in 1961. The expansion of natural rubber production is too slow to keep pace with the rapidly-increasing demand. The increment of 45,000 annual tons would have to be taken care of by synthetic rubber. An increase in demand was indicated for the rest of Western Europe. A synthetic rubber plant in France would help cut down on the outflow and increase the inflow of foreign currencies.

In 1955, the Syndicate set up earlier for engineering studies, formed the company, Société du Caoutchouc Butyl, or Socabu for short. They appointed as director-general, Pierre Caron, formerly head of the Purchasing Department of Esso France. He was faced with the concurrent tasks of building a grass-roots rubber plant and organizing an operating company.

Socabu Organization. The three principal owners of Socabu are Esso France, Michelin, and Compagnie Francaise de Raffinage, each of whom own about 22 percent. The list of remaining owners reads like a Who's Who of the French chemical and rubber industries. It includes Dunlop, Kleber-Colombes, Kuhlmann, Rhone-Poulenc, Nobel Bozel, Pechiney, and Ugine. Other than Esso France and CFR, the owners took no direct part in the project. CFR's participation was in providing half the feed isobutylene, the other half coming from Esso France's Port Jerome refinery.

Esso Research and Engineering Company is the process licensor. They, and their parent company, Standard Oil Company (N. J.), helped Socabu select a contractor for engineering and over-all project management—C F Braun & Co. of Alhambra, California. Esso Research and Engineering Company and Jersey Standard provided representation at the contractor's offices and in the field, loaned a project engineer and a butyl adviser to Socabu, and provided a start-up group from other Jersey Standard affiliates in Baton Rouge and Baytown. Esso France, (owned 63 percent by Jersey Standard) provided some purchasing and source-inspection services.

The Butyl Rubber Project. The project was kicked off in June of 1956. Esso Research and Engineering Company supplied the basic process data. Braun prepared the Job Specification at Alhambra. After the flow diagrams and basic engineering were finalized, the scene shifted to the Rome offices of Braun's subcontractor, Compagnia Tecnica Industrie Petroli. With Braun supervision, Italian engineers issued the purchase specifications and designs.

Most of the equipment came from France. In fact, the import restrictions were so strict that the owner had to demonstrate conclusively that the function of a specific item could

not be performed by French equipment before permission was given to apply for an import license. Neither schedule nor cost was sufficient justification. Some of the special finishing equipment, the cutter and stacker, for example, came from the States. Tunnel driers came from Scotland, and high-speed centrifugal compressors from Germany.

The biggest procurement problems were found in the fabrication of 3½ percent nickel reactors and piping. The use of this metal is new in France. Before this project, only one French fabricator had welded 3½ percent nickel.

There are only a few major foundries, and only one supplier of miniature instruments in France. The customers must wait their turn here. The expedient of buying pipe, valves, and fittings out of stock is generally non-existent. There are no refinery-supply houses for such stock purchases. The refineries look to each other for help.

Plant Erection. The building of the plant in France was done through a number of erection contractors. This appears to be the usual European practice. There are no completely integrated contractors who use a staff and locally-hired men in the manner of large engineering and construction contractors in the States. While the work of negotiating and coordinating the contracts was done by the project-management group, the contract itself was signed between the owner and the contractors.

The individual French worker is very industrious and conscientious. He stays on the job until the end of working hours. He takes pride in his individual craftsmanship. Rain is no reason for him to quit work, because its constancy in Normandy makes it part of his normal life. On days when it is impossible to work because of ice, the worker gets a partial payment of salary from a government agency. Contractors make contributions to the agency for this purpose. As a condition of payment to the workers, however, the contractor must certify that it was impossible to work.

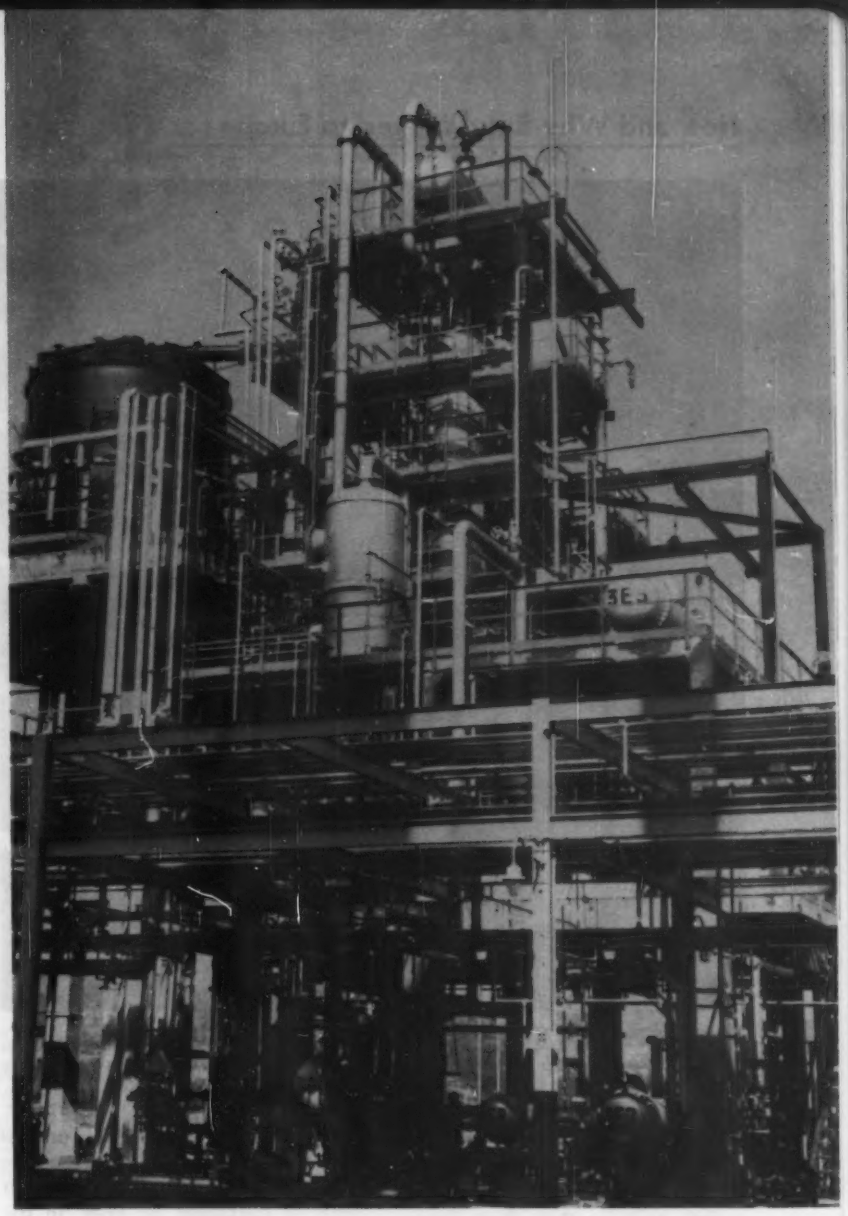

FIGURE 3—Isobutylene is extracted by sulfuric acid. Notice the acid concentrator on the elevated concrete structure along side the isobutylene regenerator.

Two Traditions Broken. The plant is located at Notre Dame de Gravenchon on the old Seine River basin, about 24 miles from Le Havre. Piling has been used for many years for all major installations on the old river bed. The possible payoff by eliminating piles justified a thorough investigation of the soils. A soil survey was conducted by Braun with the aid of Société Mecasol of Paris. The conclusion of the survey was that piles were not needed, that spread footings could be used.

Braun engineers had to overcome years of tradition and firm opposition to the use of spread footings instead of piles for foundations. The payoff of this bold engineering decision was a savings of about $200,000 installation cost and eight months of schedule.

Another tradition in this region of Normandy was to divide the work among a number of small, local contractors. It was not unusual, for example, to have three piping contractors on a job. Socabu accepted Braun's thesis that the construction schedule could not be met unless the work was done by big nationwide contractors.

With full employment in France, there was a shortage of manpower.

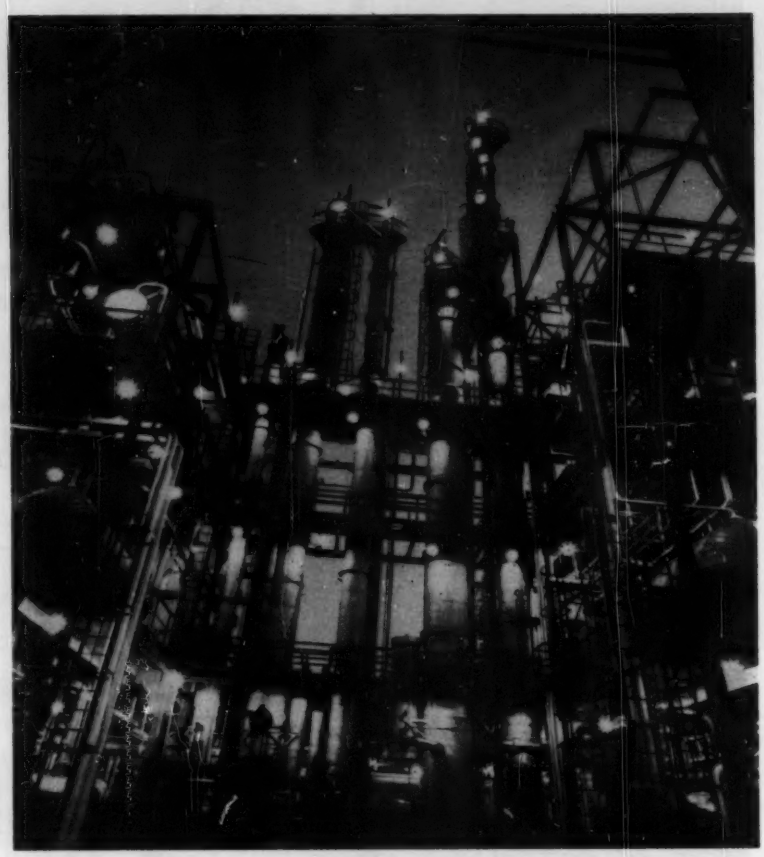

FIGURE 4—In this view of the prefractionation section, notice the use of common tower platforms which result in considerable savings in steel and give an easily operable plant.

Furthermore, in the area of the project, there was keen competition for labor. Esso France was building several units in their Port Jerome Refinery across the street. Not far away, a plastics plant was being built. Unlike the local contractors, the nationwide contractors had the possibility of bringing in men from other parts of France.

There was flexibility in having single contractors for each major portion of the work. The single piping contractor, for example, had the opportunity of moving his men around the plant if lack of materials prevented work in one area. Such flexibility did not exist on projects wherein a piping contractor was assigned to each area. Finally, fewer contractors meant easier coordination, with its benefits in schedules and cost savings.

Process and Design. The process had been developed by Esso Research and Engineering through years of operation. In brief, in the isobutylene extraction unit, 95 percent isobutylene is produced by sulfuric acid extraction from a mixed C_4 stream.

The isobutylene is brought to 99 percent in the prefractionation section of the copolymerization unit. A copolymerization of isobutylene and isoprene occurs at minus 140° F in 3½ percent nickel reactors. The catalyst is anhydrous aluminum chloride in pure methyl chloride. Methyl chloride and unreacted hydrocarbons flash overhead in large flash tanks. The slurry goes to the Finishing Building where it is dewatered in vacuum filters, calcined in tunnel driers, extruded, cooled, cut, stacked, packaged, and warehoused.

The plant is laid out for expansion to double its present capacity. The original Baton Rouge and Baytown plants were expanded through the years to the present capacities of 47,000 and 43,000 long tons per year respectively. The Polymer Corporation gradually expanded its plant at Sarnia, Ont., to 26,000 long tons per year. Such expansion took its toll in some crowding of facilities. Esso and Braun engineers asked the Baton Rouge and Baytown operators: If you could start from scratch in building this plant, what would you do? The resulting layout reflects the best thinking of operators, maintenance men, and design engineers.

A heavy duty road goes through the process area. The roads under pipeways are paved. Pumps are lined up for easy access and maintenance. Handling facilities are provided for exchanger tube-bundles, reactor agitators, compressors, and large manhole covers. There is access for cranes within the operating units. There are work areas adjacent to operating areas. A Maintenance Shop with a 15-ton overhead bridge-crane, and a central toolroom, is the central facility for most of the plant maintenance. ##

About the Author

J. Albert Curran is a senior project engineer for C F Braun & Co., Alhambra, Calif. He handles engineering and construction management of projects for the petroleum, petrochemical, chemical and process industries. Holder of a B.S. degree from the U.S. Naval Academy and a M.B.A. degree from the University of Southern California, Curran was in the Navy from 1937-46 as a damage control officer. With Braun since 1946, he has been a field engineer, assistant general superintendent, chief scheduler, Estimating Department head, project engineer and project manager.

Thermo Data for Petrochemicals

Part XXV: Chlorofluoromethanes

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The University of Texas, Austin

THE CHLOROFLUOROMETHANES represent a group of industrially important compounds ranging from the large tonnage member, carbon tetrachloride, to a relatively new member, carbon tetrafluoride. In between are members known commercially as "Freons," "Genetrons" and by other trade names. These fluorine derivatives are of increasing industrial importance, hence their thermochemical and thermodynamic properties are of importance.

The data sources are given in Table 1. Carbon tetrachloride was presented in Part X of this series[11] and is included here again for completeness and because of the better data now available. The calculations of Gelles and Pitzer[5] were refined by Albright *et al.*,[1] who took into account the effect of anharmonicity in the molecules.

TABLE 1—Reported Heat Capacities for the Chlorofluoromethanes

Compound	Temperature Range	Method	Workers	Reference
CCl_4	0 to 60°C.	Calorimetric	Mills and MacRae	14
	330 to 426°K.	Calorimetric	Pitzer	15
	250 to 600°K.	Semi-empirical	Glockler and Edgel	6
	100 to 1500°K.	Spectroscopic	Gelles and Pitzer	5
	100 to 1000°K.	Spectroscopic	Albright et al.	1
CCl_3F (Freon-11)	100 to 1500°K.	Spectroscopic	Gelles and Pitzer	5
	100 to 1000°K.	Spectroscopic	Albright et al.	1
	35 to 135°C.	Calorimetric, 1 atm.	Benning and McHarness	3
CCl_2F_2 (Freon-12)	−30 to 90°C.	Calorimetric	Masi	13
	100 to 1500°K.	Spectroscopic	Gelles and Pitzer	5
	100 to 1000°K.	Spectroscopic	Albright et al.	1
$CClF_3$ (Freon-13)	Unknown	Spectroscopic	Albright and Martin	2
	100 to 1500°K.	Spectroscopic	Gelles and Pitzer	5
	100 to 1000°K.	Spectroscopic	Albright et al.	1
CF_4 (Freon-14)	100 to 1500°K.	Spectroscopic	Gelles and Pitzer	5
	100 to 1000°K.	Spectroscopic	Albright et al.	1

TABLE 2—Free Energies of Formation, Heats of Formation and Combustion of the Chlorofluoromethanes at 25° C.

Compound	Molecular Weight	$-\Delta G_f^\circ$[16] kcal./g-mole	$-\Delta H_f^\circ$[16] kcal./g-mole	$-\Delta H_f^\circ$[9] kcal./g-mole
CCl_4 (g)	153.84	15.3	25.5	22.2[18]
CCl_3F (g)	137.38	....	....	70 ±4
CCl_2F_2 (g)	120.92	....	....	112 ±2
$CClF_3$ (g)	104.47	....	....	171 ±1
CF_4 (g)	88.01	151.8	162.5	218 ±2

TABLE 3—Heat Capacities for the Chlorofluoromethanes
cal./g-mole • °K.

T °C.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
0	19.36	18.04	16.62	15.29	13.87
18	19.85	18.56	17.17	15.86	14.45
25	20.03	18.75	17.37	16.08	14.67
100	21.60	20.50	19.25	18.06	16.76
200	22.99	22.09	21.06	20.06	18.95
300	23.89	23.13	22.31	21.48	20.56
400	24.48	23.85	23.20	22.51	21.76
500	24.91	24.38	23.83	23.25	22.63
600	25.22	24.78	24.30	23.81	23.27

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The data on free energies of formation and heats of formation at 25° C are of varying reliability. The data of the National Bureau of Standards Circular 500[16] are tabulated (Table 2) along with the heats of formation given by Kirkbride and Davidson. Since these compounds are not combustible in the usual sense of the word, heats of combustion are not given. Complete hydrolysis of the compounds to carbon dioxide and aqueous solutions of hydrofluoric and hydrochloric acids would correspond to the combustion reaction.

Much work has been done recently on the heat of formation of carbon tetrafluoride which shows that the value of N.B.S. Circular 500 undoubtedly is wrong. Values reported are:

	$-\Delta H_f^\circ$ kcal./g-mole
Kirkbride and Davidson[9]	218 ± 2
Jessup *et al.*[8]	220.4 ± 2
Scott *et al.*[17]	218.3
Duus[4]	212.7

The agreement between the results of Kirkbride and Davidson, and those of Scott *et al.* make the value of 218 kcal./g-mole appear to be the best value. This

TABLE 4—Heat Capacities for the Chlorofluoromethanes
cal./g-mole • °K.

T °K.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
100	11.36	10.37	9.49	8.80	8.31
200	16.79	15.46	14.06	12.71	11.37
273.15	19.36	18.04	16.62	15.29	13.87
291.15	19.85	18.56	17.17	15.86	14.45
298.15	20.03	18.75	17.37	16.08	14.67
300	20.08	18.80	17.42	16.13	14.73
400	22.04	21.00	19.80	18.66	17.41
500	23.27	22.41	21.44	20.49	19.43
600	24.07	23.35	22.58	21.79	20.92
700	24.61	24.01	23.39	22.73	22.02
800	25.00	24.50	23.97	23.42	22.82
900	25.29	24.87	24.41	23.94	23.42
1000	25.52	25.16	24.74	24.35	23.91

TABLE 5—Heat Capacities for the Chlorofluoromethanes
cal./g-mole • °K.

T °F.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
32	19.36	18.04	16.62	15.29	13.87
60	19.78	18.48	17.09	15.78	14.37
77	20.03	18.75	17.37	16.08	14.67
100	20.34	19.09	17.72	16.45	15.06
200	21.48	20.37	19.10	17.90	16.59
300	22.36	21.37	20.22	19.12	17.91
400	23.04	22.14	21.12	20.13	19.03
500	23.57	22.76	21.87	20.97	19.98
600	24.00	23.26	22.47	21.66	20.77
700	24.33	23.67	22.97	22.24	21.45
800	24.61	24.01	23.39	22.73	22.02
900	24.84	24.30	23.73	23.14	22.49
1000	25.04	24.54	24.02	23.48	22.89
1100	25.20	24.76	24.28	23.78	23.24

TABLE 6—Heat Capacities for the Chlorofluoromethanes
cal./g-mole • °R.

T °R.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
492	19.36	18.04	16.62	15.29	13.87
500	19.48	18.16	16.76	15.43	14.01
520	19.78	18.48	17.09	15.78	14.37
537	20.03	18.75	17.37	16.08	14.67
600	20.84	19.65	18.31	17.06	15.70
700	21.87	20.80	19.58	18.42	17.16
800	22.66	21.70	20.60	19.55	18.38
900	23.27	22.41	21.44	20.49	19.43
1000	23.76	22.98	22.12	21.27	20.31
1100	24.14	23.43	22.68	21.91	21.06
1200	24.45	23.81	23.15	22.45	21.69
1300	24.71	24.13	23.54	22.91	22.22
1400	24.92	24.40	23.86	23.28	22.66
1500	25.10	24.63	24.13	23.61	23.04

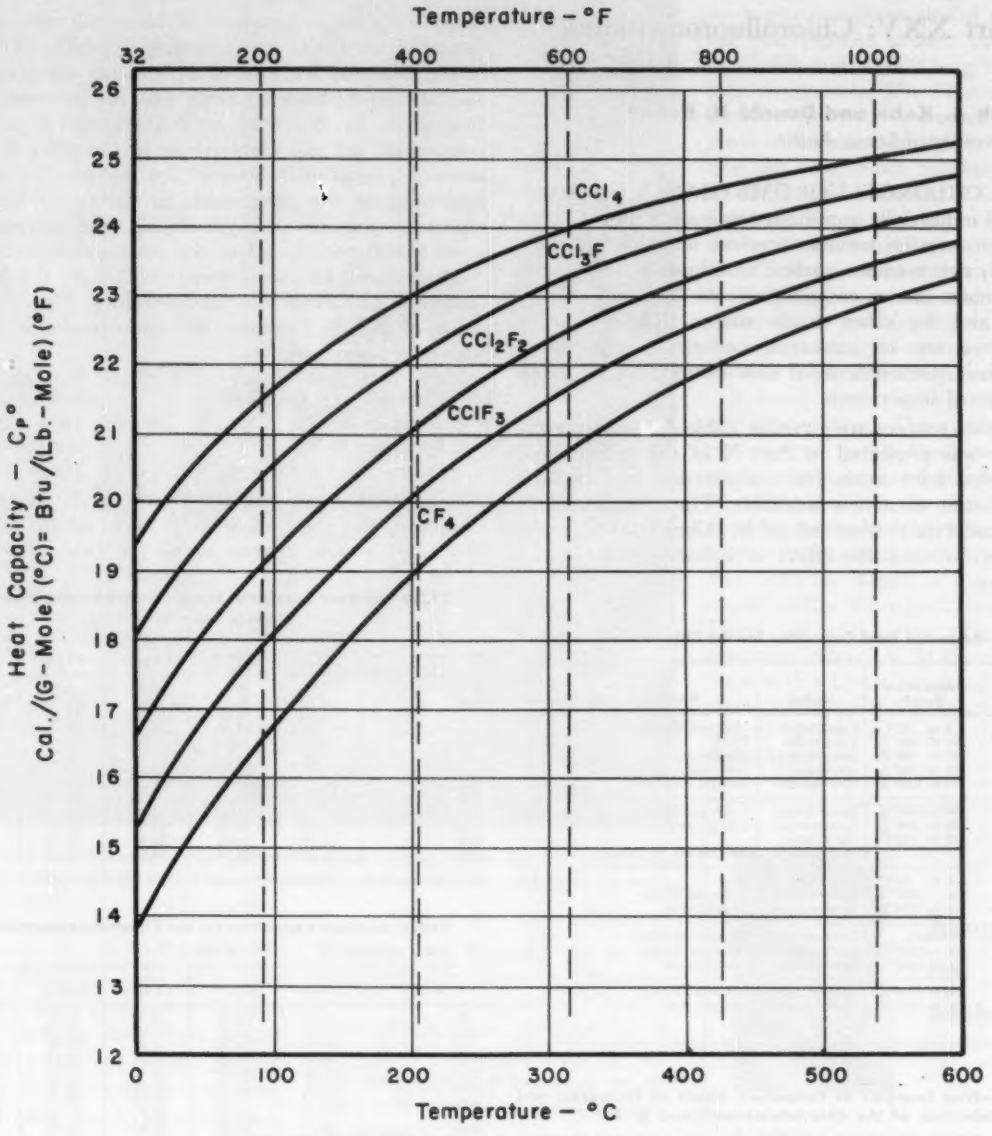

FIGURE 1—Molar heat capacities of the ideal gas.

also gives confidence to the values for the heats of formation of the other chlorofluoromethanes.

The heat of formation of carbon tetrachloride reported in N.B.S. Circular 500 (—25.5 kcal./g-mole) also is open to some question. Smith *et al.*[18] report a heat of combustion (hydrolysis) of 567.5 cal./gram, or 87.30 kcal./g-mole. Using other heats of formation of Circular 500, the heat of formation is calculated to

TABLE 7—Enthalpies for the Chlorofluoromethanes
cal./g-mole

T °C.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
0	0	0	0	0	0
18	353	330	305	280	254
25	492	460	426	391	356
100	2059	1937	1803	1675	1534
200	4276	4074	3829	3594	3330
300	6639	6336	6000	5676	5306
400	9063	8692	8278	7877	7421
500	11530	11110	10640	10160	9645
600	14040	13560	13040	12510	11940

TABLE 8—Enthalpies for the Chlorofluoromethanes
cal./g-mole

T °K.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
273.15	0	0	0	0	0
291.15	353	330	305	280	254
298.15	492	460	426	391	356
300	529	495	458	421	383
400	2640	2494	2328	2170	1993
500	4902	4670	4399	4139	3845
600	7287	6960	6602	6256	5861
700	9719	9336	8904	8483	8008
800	12200	11760	11280	10780	10260
900	14720	14230	13700	13150	12570
1000	17260	16730	16160	15580	14940

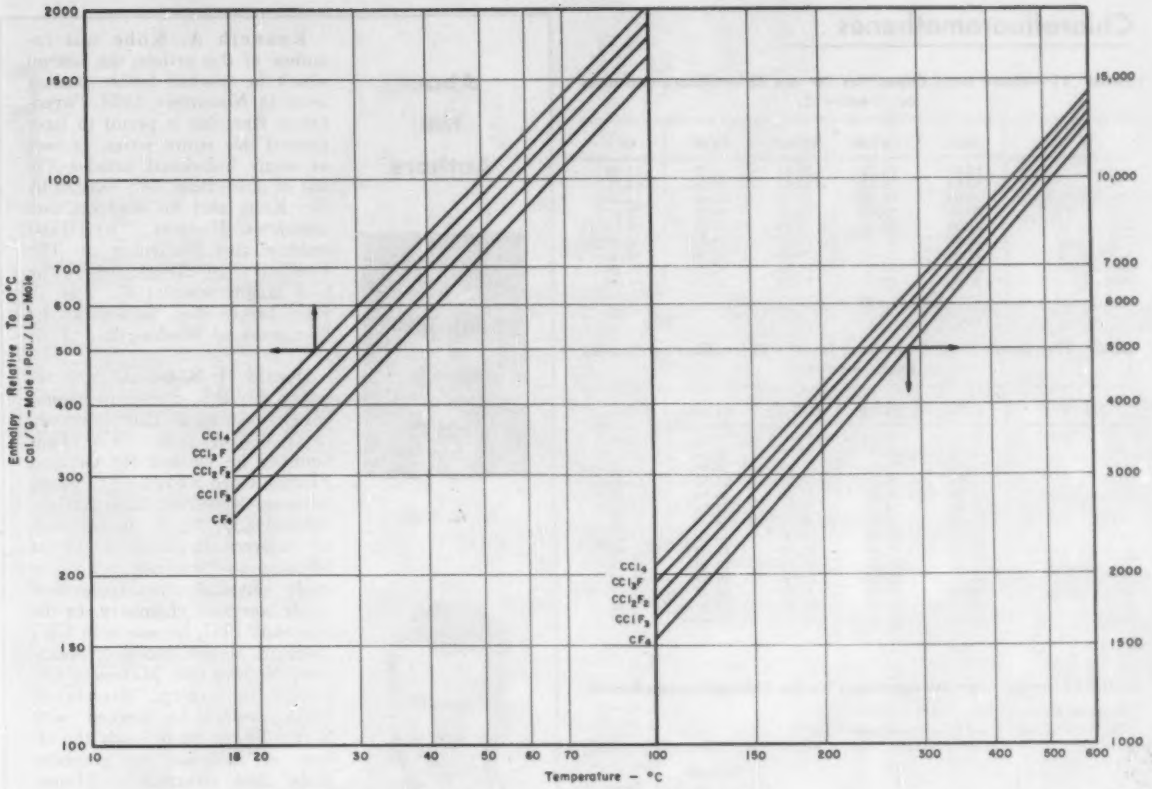

FIGURE 2—Molar enthalpies of the ideal gas state relative to the ice point, 0° C.

be —21.8 kcal./g-mole; Kirkbride and Davidson[9] report Smith's value to be —22.2 kcal./g-mole.

Obviously more work is needed on the thermochemistry of the organo-halogen compounds.

The data given by Albright *et al.*[1] were smoothed using the auxiliary function method.[7] From the smoothed data, the heat capacities of the ideal gases were calculated on all four temperature scales using the Lagrangian interpolation coefficients of Kobe and Pennington.[12] Molar heat capacities are given in Tables 3, 4, 5, and 6. These data are shown in Figure 1 on the Centigrade and Fahrenheit scales.

The Tenth General Conference of Weights and Measures[19] adopted 273.16° K. for the triple point of water, which makes the ice point 273.15° K. Hence, 0° C. = 32° F. = 273.15° K. = 491.67° R., and 25° C. = 77° F. = 298.15° K. = 536.67° R.

The molar enthalpies of the ideal gases relative to the ice point, 0° C. = 32° F., are given in Tables 7, 8, 9, and 10. The molar enthalpies in calories/gram-mole, or Pcu./lb-mole, are shown in Figure 2 as a function of the Centigrade temperature.

The mean molar heat capacities above the ice point are given on the Centigrade scale in Table 11 and on the Fahrenheit scale in Table 12.

Cubic equations for the heat capacities of these compounds were derived using the method of minimum percentage deviation.[10] Values for the coefficients for the heat capacity equations are given in Table 13. The maximum percentage deviation for all compounds is less than 0.40 percent and for carbon tetrafluoride it is less than 0.10 percent.

The data of Albright *et al.*[1] for the free energy function and for the entropy were smoothed[7] and are given in Tables 14 and 15, respectively, for completeness. Values of these functions given at temperatures

TABLE 9—Enthalpies for the Chlorofluoromethanes
Btu/lb.-mole

T °F.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
32	0	0	0	0	0
60	548	512	473	434	395
77	886	828	767	704	641
100	1356	1264	1170	1078	979
200	3449	3241	3014	2799	2558
300	5626	5330	4987	4659	4291
400	7887	7509	7060	6631	6145
500	10230	9760	9217	8695	8102
600	12620	12060	11430	10830	10140
700	15050	14410	13700	13020	12250
800	17500	16800	16020	15260	14420
900	19960	19220	18390	17550	16640
1000	22450	21660	20780	19880	18910
1100	24970	24120	23190	22230	21220

TABLE 10—Enthalpies for the Chlorofluoromethanes
Btu/lb.-mole

T °R.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
492	0	0	0	0	0
500	161	151	139	127	116
520	548	512	473	434	395
537	886	828	767	704	641
600	2189	2044	1895	1752	1594
700	4316	4072	3796	3534	3241
800	6527	6197	5810	5440	5024
900	8822	8406	7918	7450	6921
1000	11200	10680	10100	9540	8909
1100	13600	13000	12340	11700	10970
1200	16030	15370	14630	13920	13100
1300	18480	17770	16970	16180	15300
1400	20960	20190	19350	18480	17550
1500	23470	22640	21740	20810	19840

TABLE 11—Mean Heat Capacities for the Chlorofluoromethanes
cal./g-mole • °C.

T °C.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
0	19.34	18.02	16.61	15.28	13.86
18	19.61	18.33	16.94	15.56	14.11
25	19.68	18.40	17.04	15.64	14.24
100	20.59	19.37	18.03	16.75	15.34
200	21.39	20.37	19.14	17.97	16.65
300	22.12	21.12	20.00	18.92	17.69
400	22.66	21.73	20.70	19.69	18.55
500	23.06	22.22	21.28	20.32	19.29
600	23.40	22.60	21.73	20.85	19.90

TABLE 12—Mean Heat Capacities for the Chlorofluoromethanes
Btu/lb.-mole • F.

T °F.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
32	19.34	18.02	16.61	15.28	13.86
60	19.57	18.29	16.89	15.50	14.11
77	19.68	18.40	17.04	15.64	14.24
100	19.94	18.59	17.21	15.85	14.40
200	20.54	19.29	17.94	16.66	15.23
300	20.99	19.89	18.61	17.38	16.01
400	21.43	20.40	19.18	18.02	16.70
500	21.86	20.86	19.70	18.58	17.31
600	22.24	21.23	20.12	19.05	17.83
700	22.53	21.57	20.51	19.49	18.32
800	22.77	21.87	20.86	19.87	18.76
900	23.00	22.14	21.19	20.22	19.17
1000	23.20	22.38	21.47	20.53	19.54
1100	23.38	22.58	21.71	20.81	19.87

TABLE 13—Heat Capacity Equations for the Chlorofluoromethanes
Equation: $C_p^\circ = a + b(t) + c(t)^2 + d(t)^3$
Units: cal./g-mole·°K. or °C. = Btu/lb.-mole·°F. or °R.

Compound	T	a	$b \cdot 10^2$	$c \cdot 10^5$	$d \cdot 10^8$	ERROR Max. %	ERROR Avg. %	Temp. Range
CCl_4	°K.	9.288	5.099	—5.729	2.257	0.36	0.20	273—1000
	°C.	19.40	2.474	—3.880	2.257	...	...	0— 727
	°R.	9.288	2.833	—1.768	0.3870	...	...	492—1800
	°F.	18.96	1.452	—1.234	0.3870	...	...	32—1340
CCl_3F	°K.	6.964	5.563	—6.144	2.406	0.33	0.21	273—1000
	°C.	18.07	2.745	—4.172	2.406	...	...	0— 727
	°R.	6.964	3.091	—1.896	0.4125	...	...	492—1800
	°F.	17.57	1.609	—1.327	0.4125	...	...	32—1340
CCl_2F_2	°K.	5.085	5.685	—5.930	2.215	0.25	0.15	273—1000
	°C.	16.64	2.941	—4.115	2.215	...	...	0— 727
	°R.	5.085	3.158	—1.830	0.3798	...	...	492—1800
	°F.	16.11	1.715	—1.306	0.3798	...	...	32—1340
$CClF_3$	°K.	3.311	5.829	—5.846	2.124	0.18	0.12	273—1000
	°C.	15.30	3.111	—4.106	2.124	...	...	0— 727
	°R.	3.311	3.238	—1.804	0.3642	...	...	492—1800
	°F.	14.74	1.810	—1.301	0.3642	...	...	32—1340
CF_4	°K.	1.666	5.830	—5.502	1.897	0.10	0.05	273—1000
	°C.	13.87	3.249	—3.947	1.897	...	...	0— 727
	°R.	1.666	3.239	—1.698	0.3253	...	...	492—1800
	°F.	13.29	1.883	—1.249	0.3253	...	...	32—1340

TABLE 14—Free Energy Function for the Chlorofluoromethanes
$-\frac{(G^\circ - H_o^\circ)}{T}$ = cal./g-mole • °K. in the gaseous state

T °K.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
100	48.19	49.91	49.36	47.18	42.75
200	55.16	56.49	55.59	53.15	48.50
273.15	59.07	60.12	58.95	56.27	51.41
291.15	59.93	60.92	59.69	56.95	52.04
298.15	60.25	61.22	59.97	57.21	52.28
300	60.34	61.30	60.04	57.28	52.34
400	64.58	65.27	63.72	60.70	55.49
500	68.23	68.71	66.93	63.69	58.26
600	71.45	71.76	69.78	66.35	60.75
700	74.33	74.49	72.36	68.78	63.03
800	76.93	76.96	74.71	71.01	65.13
900	79.32	79.24	76.88	73.06	67.09
1000	81.48	81.37	78.89	74.97	68.89

on the Kelvin scale can be transformed to any other temperature scale using Lagrangian interpolation coefficients.[12]

About the Authors

K. A. Kobe

D. H. Kobe

Kenneth A. Kobe was co-author of this article, the last on which he worked before passing away in November, 1958. PETROLEUM REFINER is proud to have carried this entire series, as well as many individual articles (34 out of more than 200) written by Dr. Kobe and his students and associates. He was a brilliant teacher and researcher at The University of Texas, where he had taught since 1941. For 10 years before that, he was at the University of Washington.

Donald H. Kobe, the son, received his B.S. degree in chemical engineering at The University of Texas in June, 1956. That Summer he worked for General Electric Corp.'s Chemical Process Section, Research laboratory, Schenectady, N. Y. In the Fall he entered the University of Minnesota's Graduate School to study physical chemistry and teach inorganic chemistry. In the Summer, 1957, he was with GE's Hanford atomic products operation, Nonmetallic Materials Development Group, Richland, Wash., where he worked with X-ray diffraction to study the effects of radiation on graphite. Kobe then returned to Minnesota to study physics, and in Summer, 1958, resumed his work at Hanford. He received his M.S. degree in physics in June, 1959, and has resumed graduate study of that field.

TABLE 15—Entropy of the Chlorofluoromethanes
S° = cal./g-mole • °K. in the gaseous state

T °K.	CCl_4	CCl_3F	CCl_2F_2	$CClF_3$	CF_4
100	57.04	58.45	57.64	55.29	50.75
200	66.75	67.29	64.65	62.56	57.34
273.15	72.41	72.52	70.21	66.92	61.27
291.15	73.65	73.69	71.44	67.90	62.17
298.15	74.13	74.13	71.90	68.28	62.51
300	74.25	74.25	72.02	68.38	62.60
400	80.29	79.98	77.38	73.38	67.21
500	85.34	84.84	82.00	77.77	71.33
600	89.67	89.01	86.01	81.62	75.01
700	93.42	92.68	89.56	85.05	78.32
800	96.73	95.91	92.73	88.12	81.32
900	99.72	98.83	95.57	90.89	84.05
1000	102.38	101.49	98.19	93.46	86.53

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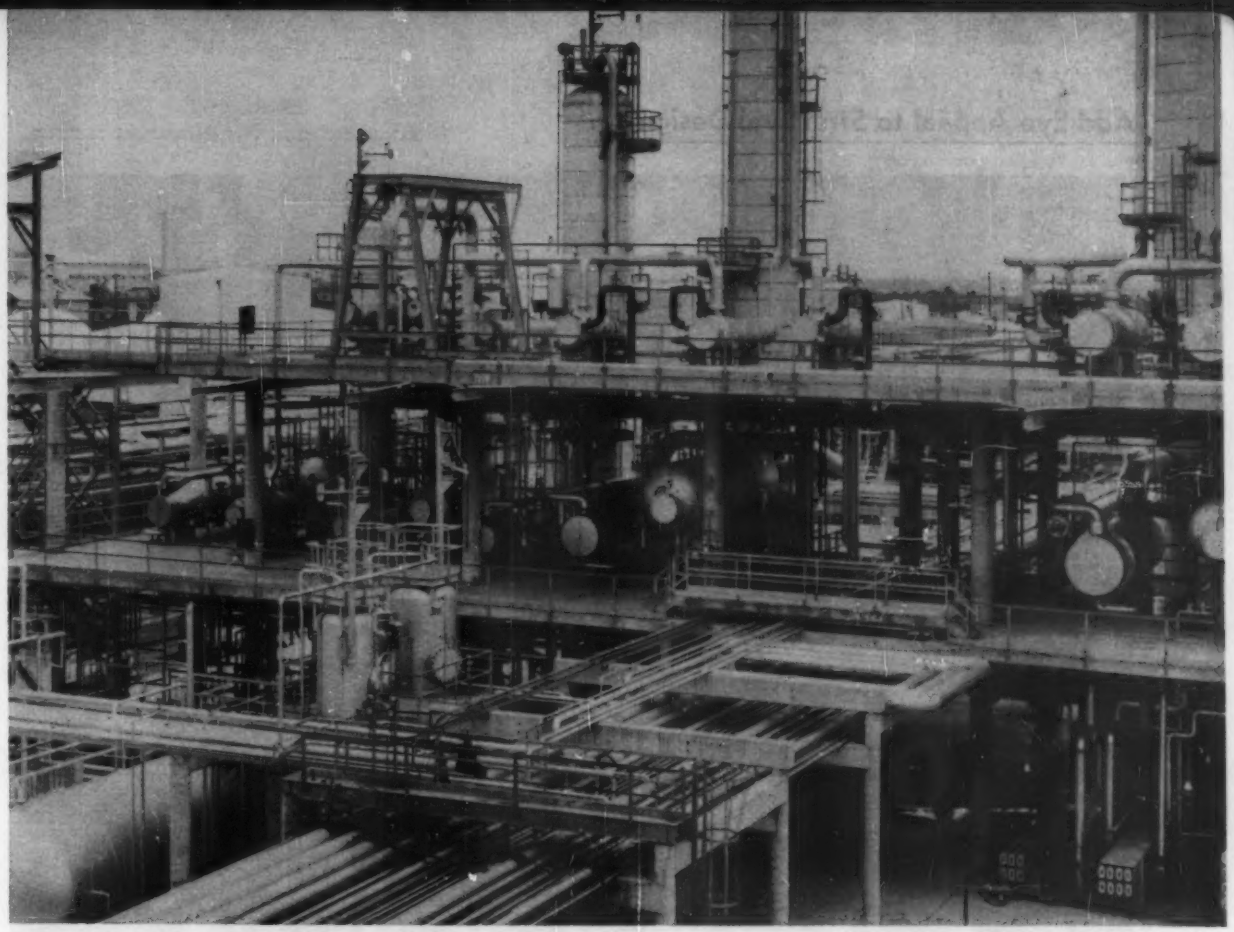

FIGURE 1—Engineering efficiency plus eye appeal are featured in this exchanger structure.

Add Eye Appeal to Structural Design

Flat plate exchanger structures supported on monolithic columns combine appearance and good engineering design

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RECENT INSTALLATION of an exchanger structure at Sinclair's Houston refinery demonstrates the possibility of design combining engineering efficiency with eye appeal.

The exchanger structure was engineered with the aim of demonstrating that attractive design and functionality are not necessarily incompatible. Good engineering design has traditionally been concentrated on performance, durability and economy with pleasing appearance running a poor fourth. The fact that it hasn't been completely squeezed out at the rail has often been a result more of happy chance than of conscious planning and imagination.

In the petrochemical industry, the requirement that exchanger structures be fireproof narrows the field of suitable materials of construction to steel and concrete. Considering these alternatives, steel structures would be preferred from the standpoints of possible additions and changes, piping accessibility and freedom of equipment support. Economically and esthetically, however, concrete was the logical choice.

The only decision remaining was whether the design should be based on conventional beams and slabs or on flat plates supported on monolithic columns.

Usually an exchanger structure of reinforced concrete would be no higher than 40 feet above the fin-

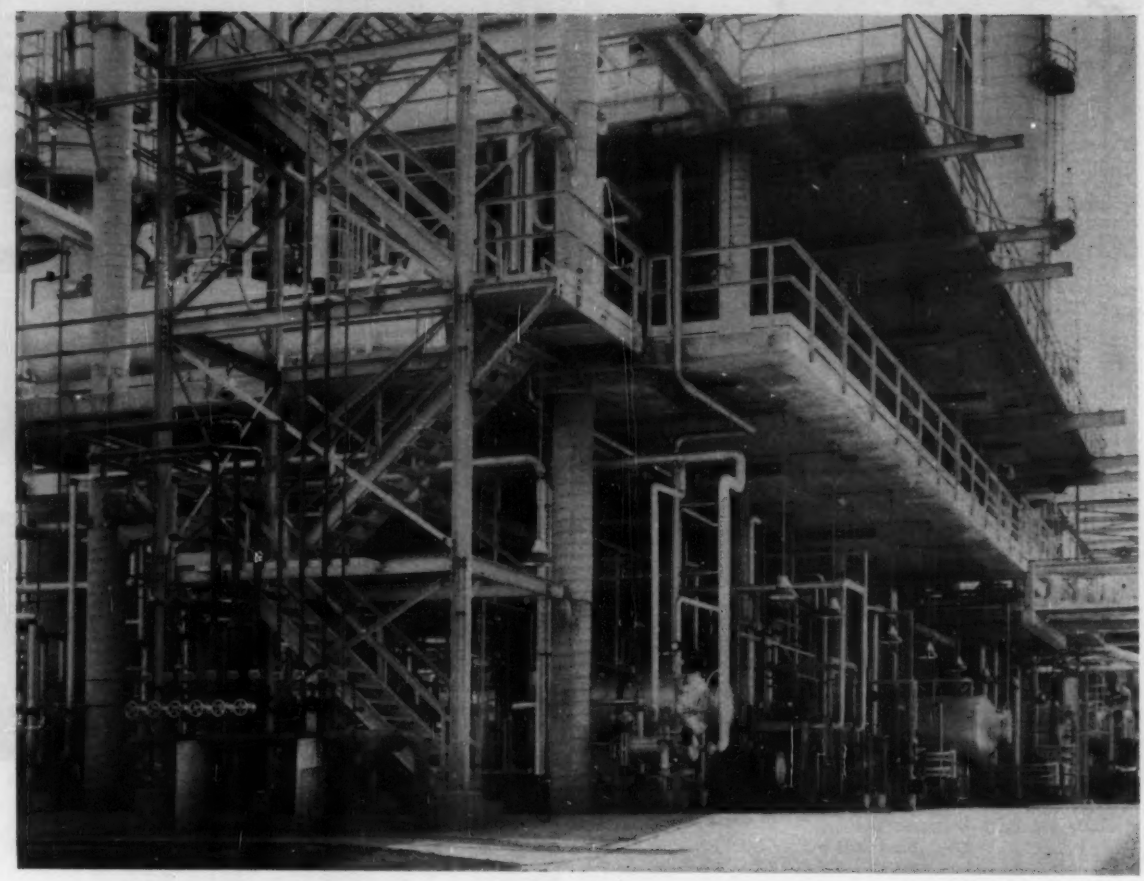


FIGURE 2—An end view shows the trim lines of the flat plates cantilevered over the monolithic columns.

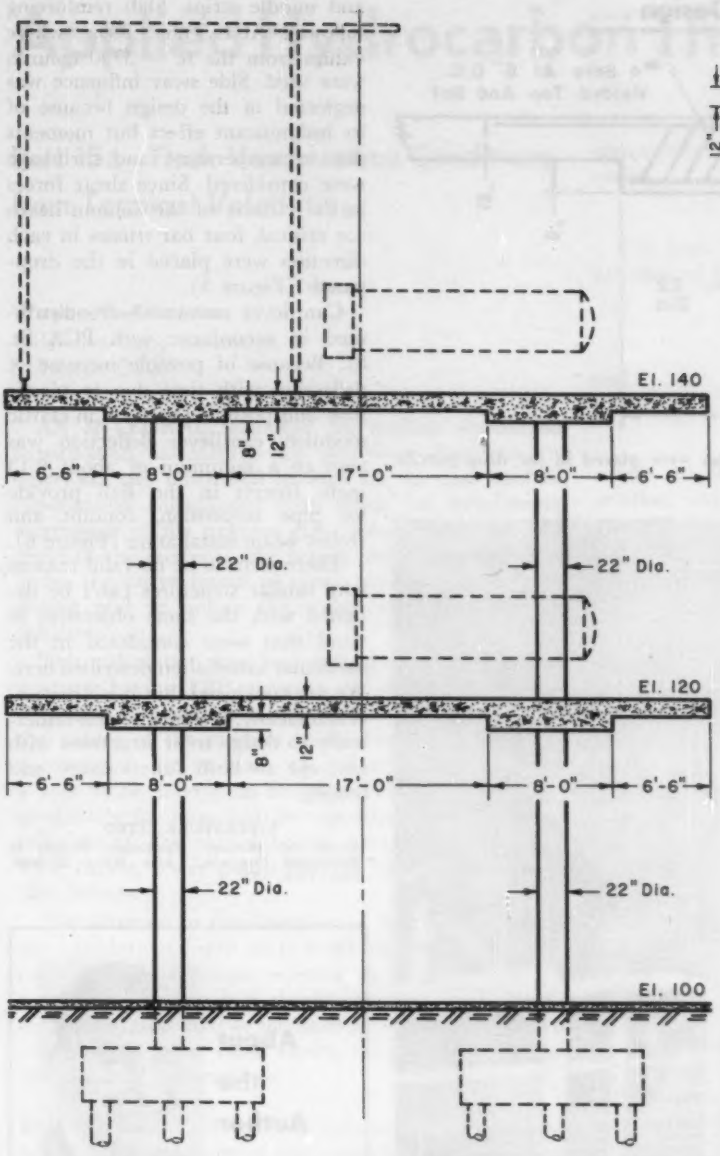
ished grade (two levels). If tubulars must be supported at a level higher than 40 feet, a combination of reinforced concrete and fireproofed structural steel would be economical, but structures of this type with three or four rows of columns and heavy beams look heavy —and ugly. The flat plate structure shown in Figures 1 and 2 incorporates both the engineering and architectural features aimed for.

Specifications called for support of a total load of 400 pounds per square foot, a live load of 250 pounds and a dead load of 150 pounds. The design allowed for a Gantry crane with maximum wheel reaction of 7 kips each; its location is shown in Figure 3. The overall slab thickness is 12 inches with drop panels 8 feet square by 8 inches thick at the spring areas of the columns (Figure 4). The circular columns have a diameter of 22 inches and are spaced 25 feet by 24 feet. The whole structure is 160 feet long and 46 feet wide—clearance between the two levels is 19 feet except under the drop panels, where it is 18 feet 4 inches. A feature making it possible to locate towers close to the structure is the 10 foot, 6 inch cantilever of the slab on both sides.

The Portland Cement Association Concrete Information St. 81 was followed for elastic analysis design. The exchanger structure was considered as a monolithic, three-dimensioned column and plate unit. Dimensional coefficient relationships were calculated from Table 2, PCA St. 81, for purposes of moment distribution.

Calculations. The calculated value for equivalent depth of the moment of inertia for the slab and drop-panel section was 16.6 inches; the relation of the equivalent shear head depth to the minimum slab thickness calculated from $r = \frac{(16.6 - 12)\text{ in.}}{12\text{ in.}}$ 0.38. The relation of the hutch width to the maximum span length was calculated to be 0.16 and the following data were selected from Table 2 (loc. cit.): carry-over factor, 0.61; stiffness coefficient, 6.6; fixed and moment coefficient, 0.095. Slab stiffness was calculated using the above data from $K = k\frac{I}{L}$ column stiffness was calculated from $K_1 = \frac{4I_1}{h}$; where h = column height. Moments for different live load location were distributed according to the foregoing data.[1]

In accordance with Section 1003 (c), American Concrete Institute 318-56, selected maximum negative and positive moments were subdivided between the column strips



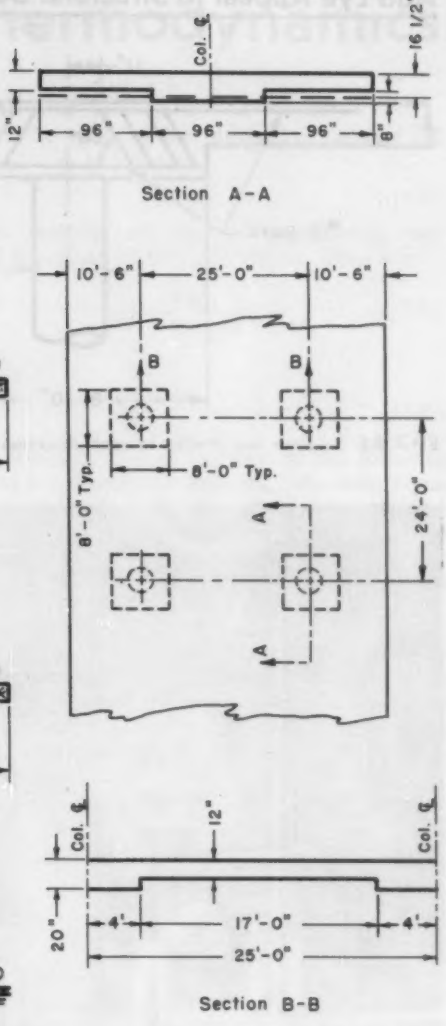


FIGURE 3—Eight-foot square by eight-inch drop panels are centered at the spring areas of the columns.

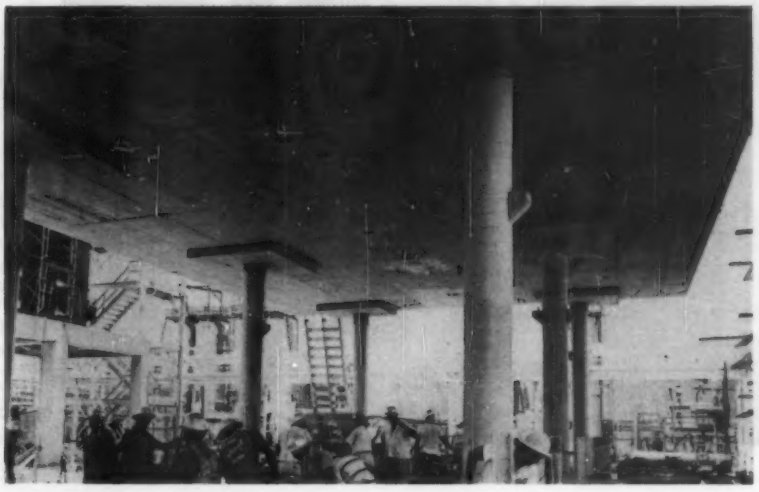


FIGURE 4 — Construction photo shows the cantilevered plate, drop panels, columns and piping inserts.

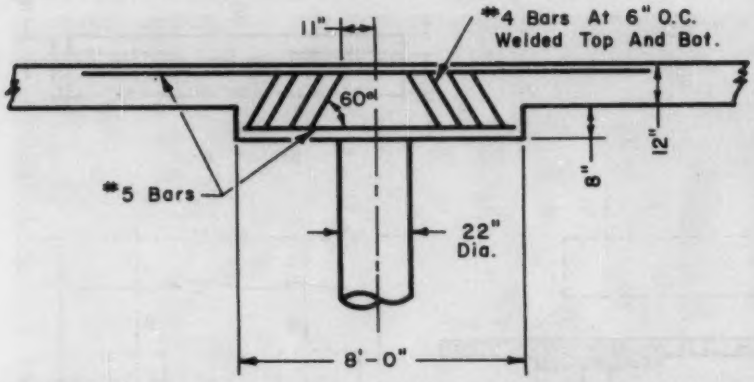


FIGURE 5—Four bar trusses in each direction were placed in the drop panels.

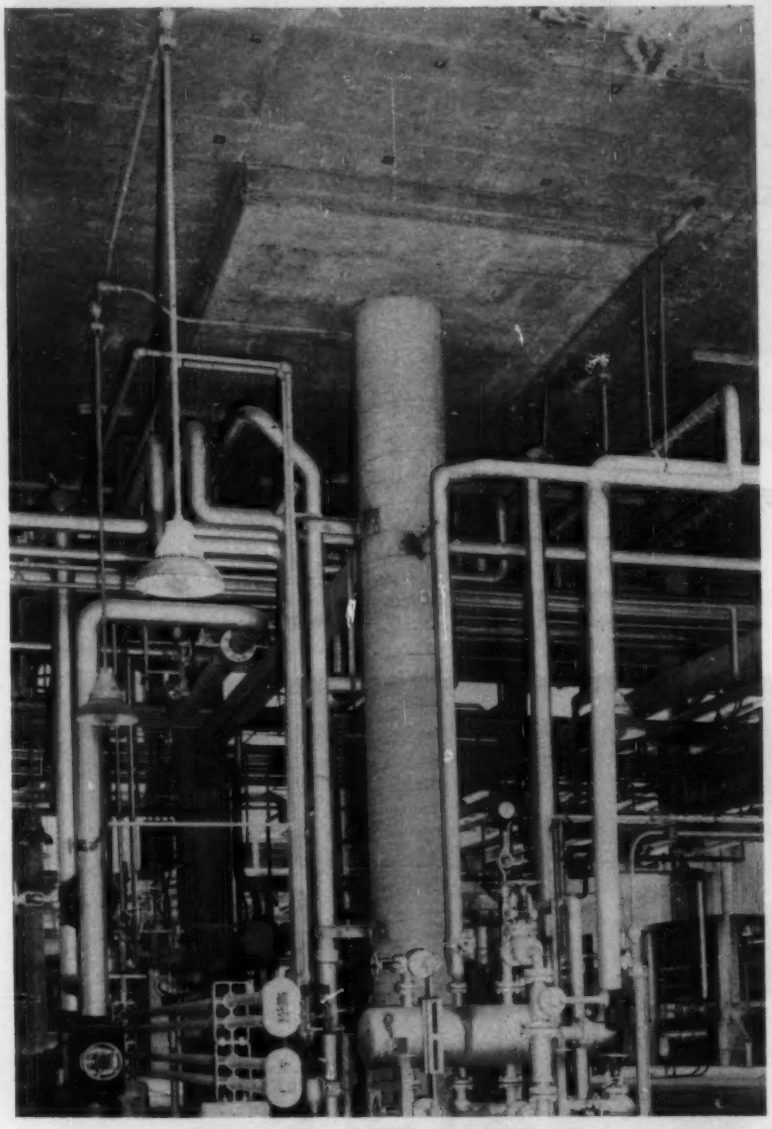


FIGURE 6—Inserts support piping and conduit.

and middle strips. Slab reinforcing followed ACI Table 305a, where values from the $fc' = 3750$ column were used. Side sway influence was neglected in the design because of its insignificant effect but moments due to temperature and shrinkage were considered. Since shear forces in the vicinity of the column heads are critical, four bar trusses in each direction were placed in the drop-panels (Figure 5).

Cantilever moments were distributed in accordance with PCA St. 81. Because of possible increase of deflection with time due to plastic flow and possible variation in elastic modulus, cantilever deflection was kept to a minimum of about 0.15 inch. Inserts in the slab provide for pipe suspension, conduit and trolley beam installation (Figure 6).

There seem to be no valid reasons why similar structures can't be designed with the same objectives in mind that were considered in the particular installation described here. We are convinced that it is practical economically, technically and esthetically to design most structures with and eye to both functionality and beauty.

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About the Author

John Makaretz, a structural engineer for Badger Manufacturing Co., has had wide experience with concrete in building dams, bridges, and in heavy industrial construction. After receiving a M.S. degree in engineering from Lwow Institute of Technology in Poland, he practiced structural engineering in Europe for several years. Before joining Badger, he was chief structural engineer with Thomas Worcester Co., Boston. During this time he was in charge of designing the new prestressed concrete bridge spanning the Connecticut River at Hartford. Makaretz is a member of the Prestressed Concrete Institute.

Applied Hydrocarbon Thermodynamics

Part 15a – Flash Vaporization Conditions from Terminal Volatilities

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AN INTEGRAL technique for making equilibrium vaporization calculations for petroleum fractions was described and illustrated in Part 14. In that method, vaporization calculations were made for infinitesimal increments of the mixture (i.e., points along the TBP curve of the mixture), the results plotted, and the area under the curve found to check phase equilibria conditions and to obtain the total distribution for the mixture.

This calculation can be made for multicomponent mixtures having TBP curves of any shape. The number of points required for these calculations depends upon the nature of the mixture being distilled. It might be necessary to use as many as a dozen points to define a wide stock, having an irregularly shaped TBP curve, adequately for integral-type vaporization or distillation calculations. For narrow boiling cuts of regular shaped TBP curves, fewer points may be used to shorten the calculations.

The ultimate in simplification of the TBP curve and the calculations based on it is the use of two points on coordinates that permit representing the TBP curve as a straight line. Such a simplification is made in this installment and used as the basis for developing analytical solutions from which charts are prepared for equilibrium flash vaporization.

Basic Formulas. A material balance on a single-stage equilibrium separation of vapor and liquid states for one mole of feed

$$Vy + (1 - V)\,x = x_f \qquad (15.1)$$

where: V = vapor fraction of feed

When using the relative volatility, α, vs boiling point relationship to characterize the mixture, as well as define the volatility vs temperature behavior of the mixture, the vapor-liquid equilibria relationship is

$$y = \frac{\alpha x}{I} \qquad (15.2a)$$

where,

$$I = \int_0^\alpha \alpha x\, d\alpha \qquad (15.2b)$$

The limits of 0 and ∞ in Equation (15.2b) mean that the integration is performed for the entire composition range, i.e., from $\alpha = 0$ to $\alpha = \infty$. For mixtures of finite components, the value of the integration constant becomes

$$I = \Sigma \alpha x \qquad (15.2c)$$

The basic formulas are obtained by algebraic combination of Equations (15.1) and (15.2). They are

$$x = \frac{Ix_p}{V\alpha + (1 - V)\,I} \qquad (15.3a)$$

and

$$y = \frac{\alpha x_p}{V\alpha + (1 - V)\,I} \qquad (15.3b)$$

where the constant, I, is determined by the following relation, which is found by computing $\int y d\alpha$ from Equation (15.3b) and setting the integral equal to unity:

$$\int_0^\alpha \frac{\alpha x_p d\alpha}{V\alpha + (1 - V)\,I} = 1 \qquad (15.4)$$

The last formula, for determining the constant I, is derived from the general rule that the integral of any composition distribution function over its whole range of volatility is equal to unity. This is the generalization of the usual rule that the sum of fraction concentrations must equal unity.

After the composition distribution functions have been obtained, the volatility curves are derived by integration, using the universal relation

$$W = \int_0^\alpha x d\alpha \qquad (15.5)$$

where: W = fraction of charge remaining in still pot at any point of a TBP distillation assay. Subscripts F, L, or V identify W with the feed or equilibrium liquid or vapor. With relative volatility being used to characterize the mixture as well as to define the vaporization behavior, W_F, W_L, or W_V are functions of α. This is sometimes written $W_F(\alpha)$, $W_L(\alpha)$, or $W_V(\alpha)$.

An expression similar to Equation 15.5 may be written for y. From the volatility curves, in turn, the conventional TBP curves can be calculated by the volatility-boiling point correlation.

Formulas for Predicting TBP of EFV Vapor and Liquid. Where the composition of the feed is characterized by TBP data, integration of the general formulas of the preceding section must usually be carried out graphically or numerically; but if the composition distribution or volatility curve function can be expressed or approximated by an explicit formula, the integrations can often be effected mathematically with much saving of labor.

As will be shown by specific examples in a later section of this series, the volatility curves for all of the several petroleum fractions examined in connction with this study are very nearly linear relationships between W (i.e., 1.0 - fraction off) and log α. All of the follow-

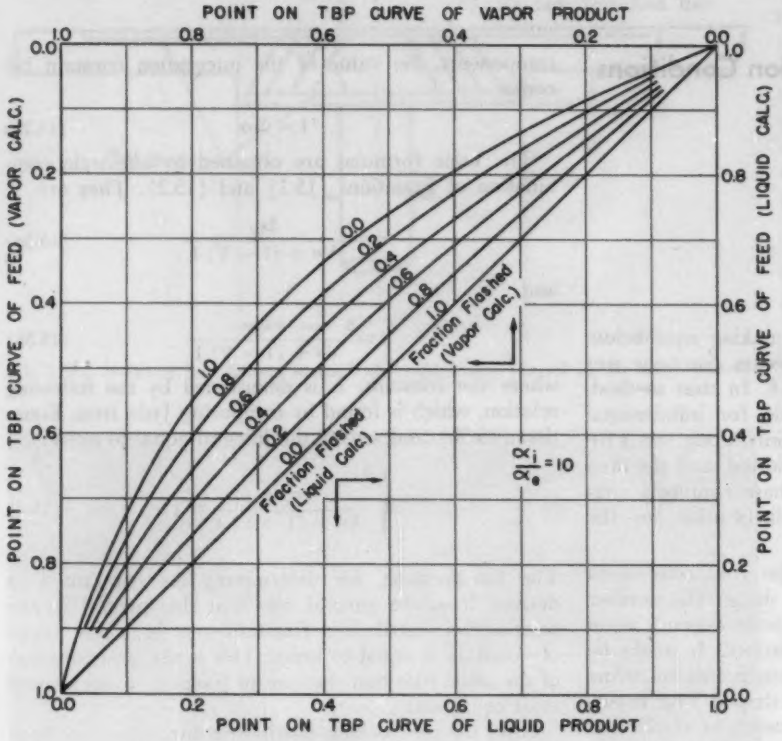

POINT ON TBP CURVE OF VAPOR PRODUCT
POINT ON TBP CURVE OF FEED (VAPOR CALC.)
POINT ON TBP CURVE OF FEED (LIQUID CALC.)
POINT ON TBP CURVE OF LIQUID PRODUCT
Fraction Flashed (Vapor Calc.)
Fraction Flashed (Liquid Calc.)
$\alpha_i/\alpha_e = 10$

FIGURE 15.1—Transformation of TBP curves of feed into TBP curves of products for $\alpha_1/\alpha_e = 10$.

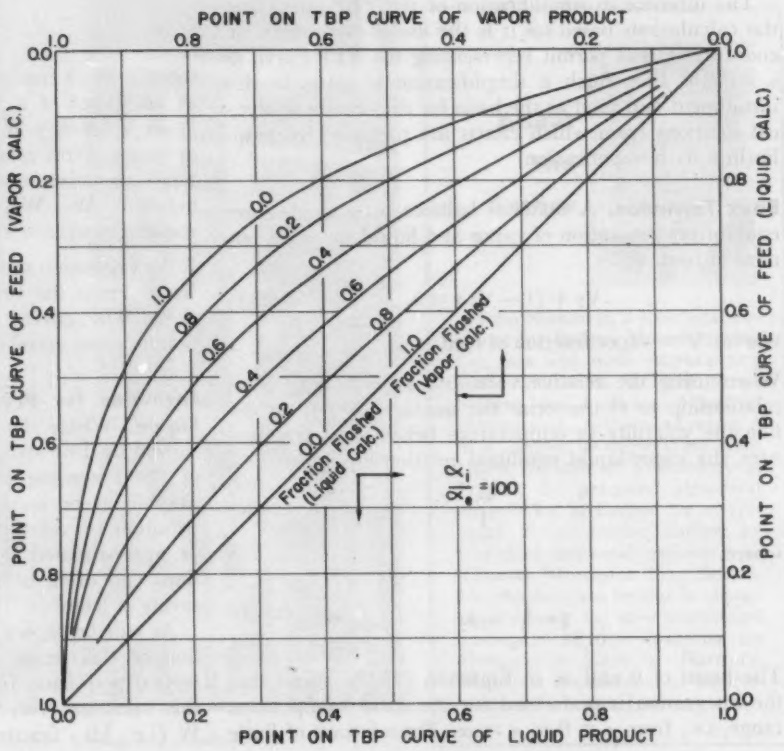

POINT ON TBP CURVE OF VAPOR PRODUCT
POINT ON TBP CURVE OF FEED (VAPOR CALC.)
POINT ON TBP CURVE OF FEED (LIQUID CALC.)
POINT ON TBP CURVE OF LIQUID PRODUCT
Fraction Flashed (Vapor Calc.)
Fraction Flashed (Liquid Calc.)
$\alpha_i/\alpha_e = 100$

FIGURE 15.2—Transformation of TBP curves of feed into TBP curves of products for $\alpha_1/\alpha_e = 100$.

ing calculations are based on the assumption that this linearity is exact.

Mathematically, the most general form for this assumption is

$$W_F = \frac{\log \frac{\alpha}{\alpha_e}}{\log \frac{\alpha_1}{\alpha_e}} \qquad (15.6)$$

where α_1 and α_e are respectively the relative volatilities of the components at the initial and end points of the TBP curve. In other words, W_F is a linear function of log α. With the linearity assumption made, these two constants are sufficient to characterize the composition of the feed.

Differentiation of Equation (15.6) gives, by the inverse of Equation (15.5), the composition distribution of the feed; and substitution of this expression into the general Equations (15.3) and (15.4) gives the composition distributions of the products. The volatility curves of the latter streams are, however, more useful in practical applications; and these can be obtained by integration of Equation (15.5). The results are:

$$W_L = \frac{1}{(1-V)\log r_a} \log \frac{\frac{\alpha}{\alpha_e}(r_a - 1)}{\frac{\alpha}{\alpha_e}(r_a^V - 1) + (r_a - r_a^V)} \qquad (15.7a)$$

and

$$W_V = \frac{1}{V \log r_a} \log \frac{\frac{\alpha}{\alpha_e}(r_a^V - 1) + (r_a - r_a^V)}{r_a - 1} \qquad (15.7b)$$

where

$$r_a = \frac{\alpha_1}{\alpha_e}$$

The limiting cases of vapor composition at the bubble point and liquid composition at the dew point are:

$$W_V = \frac{\alpha - \alpha_e}{\alpha_1 - \alpha_e}, \quad V = 0 \qquad (15.8a)$$

$$W_L = \frac{\alpha_e^{-1} - \alpha^{-1}}{\alpha_e^{-1} - \alpha_1^{-1}}, \quad V = 1 \qquad (15.8b)$$

TBP Transformation Curves. A series of charts, relating the percent off on the TBP curves of the equilibrium vapor and liquid products with the corresponding (i.e., at same TBP temperature) percent off on the TBP curve of the feed, have been prepared from the equations developed above. The parameters of these charts are the fraction flashed and the terminal α ratio, r_a. These charts are presented as Figures 15.1 through 15.4 for four values of the ratio (α_1/α_e).

Preparation of these charts was reasonably straightforward, involving the solution of Equations (15.7a), (15.7b), (15.8a), and (15.8b) in a systematic manner for the entire range of the TBP distillation curves and then plotting the (1-W) values for the products vs the corresponding values for the feed. Separate plots were necessary for each (α_1/α_e) ratio with the fraction vaporized as a parameter on each plot. The symmetry of the resulting curves made a consolidation possible by reversing the abscissa and ordinate scales, thus reducing the calculating and plotting work.

As pointed out earlier, the use of α values to identify the components of the mixture eliminates the true boiling point temperatures from the computations while taking into account the relative volatilities of the innumerable components in the mixture at the particular flashing conditions. This is most convenient as it consolidates these two effects into the same charts. To illustrate, the same petroleum fraction will have different (α_1/α_e) ratios at different flashing conditions. In other words, the value of the (α_1/α_e) ratio not only accounts for the boiling width of the petroleum fraction in estimating the TBP assays of its equilibrium vapor and liquid products from flash vaporization; it also accounts for the effects of the flashing temperature and pressure conditions. Therefore, the flashing conditions do not appear in these charts directly.

Although Figures 15.1 through 15.4 were developed for the special case, represented by Equation (15.6) (and Figure 15.6 later), where log α vs W_F gives a straight line, these charts are not strictly limited to this case because all irregularities that occur in the feed TBP curve are reflected in the TBP curves of the products by means of these charts. For the case where log α vs W_F (or log α vs volume percent off) is not a perfectly straight line, the best possible straight line should be drawn to establish terminal values of α. The (α_1/α_e) ratio thus determined is used in applying charts illustrated by Figures 15.1 through 15.4, etc., to get the relationship between the TBP curves of the feed and the products. In plotting the product TBP curves on temperature vs liquid volume percent off scales, the temperatures are obtained from the actual feed TBP. In this procedure the irregularities, that were eliminated in the previous steps of the calculations, are made to reappear in plotting the TBP curves of equilibrium vapor and liquid products.

Relative Volatility Correlation. For the application of the charts represented by Figures 15.1 through 15.4, relative volotilities are required as a function of flashing conditions and some characteristic of the components of the petroleum fractions. A graphical correlation giving α values (i.e., K value of component divided by K value of reference component at same conditions) as a function of normal boiling point and flashing temperature was prepared previously[7] and is presented here as Figure 15.5 for illustration purposes only.

As indicated by the note on Figure 15.5, this relative volatility correlation is not recommended for design calculations. It is included for illustration purposes because the examples and solutions most readily available had been solved using this α chart.

The following discussion, describing the preparation of this α chart, is included to explain the source of Figure 15.5

The reference substance chosen is the 350° F atmospheric boiling point component because this is a boiling point appearing in the petroleum fractions of most interest and because it is a boiling point most suitable from the standpoint of the source of the K values used in preparing Figure 15.5.

This α plot was prepared from readings of K values taken from large-scale copies of Hadden's[39] nomograms (identified as Figures 1 and 2 in Hadden's paper). It was found that relative volatilities obtained from this

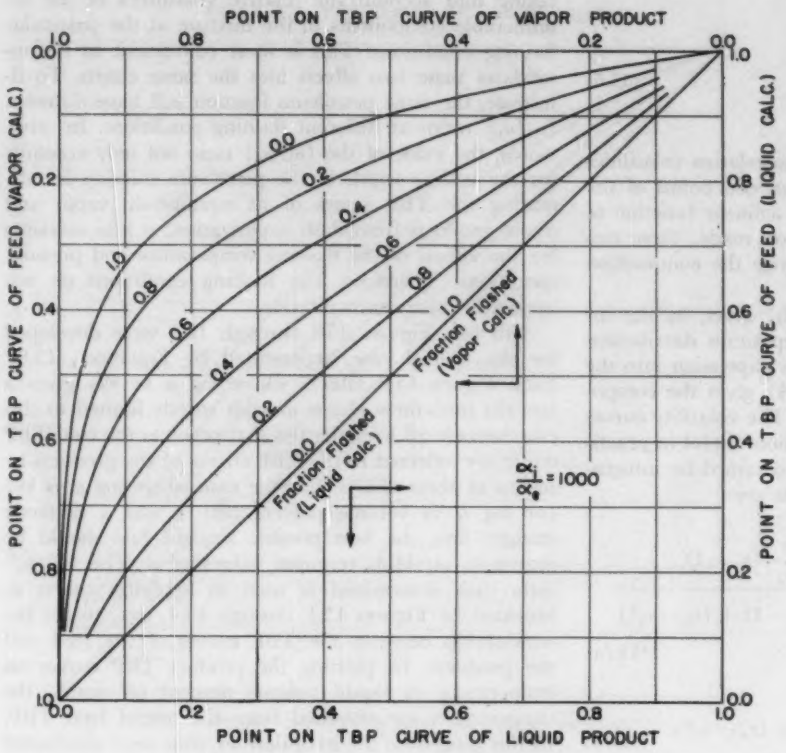


FIGURE 15.3—Transformation of TBP curves of feed into TBP curves of products for $\alpha_1/\alpha_e = 1000$.

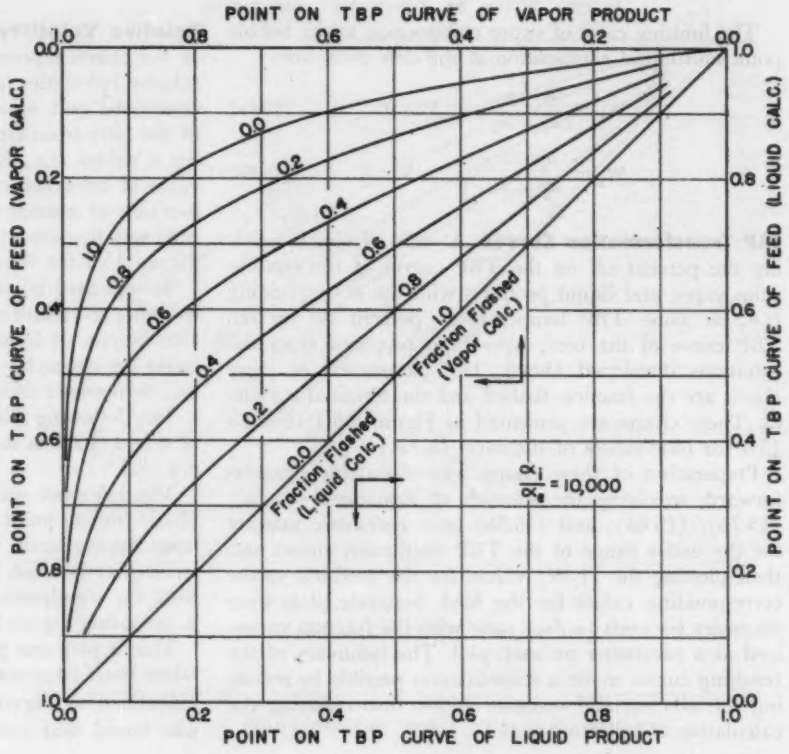


FIGURE 15.4—Transformation of TBP curves of feed into TBP curves of products for $\alpha_1/\alpha_e = 10{,}000$.

source were independent of the flashing pressure in the range of interest, i.e., 14.7 to 300 psia. Hence, it was possible to simplify the correlation for the relative volatility by omitting pressure, as shown in Figure 15.5.

The Hadden[39] nomograms were based on experimental values of K, the equilibrium phase distribution ratio, the data of White and Brown[40] being representative of the data used for petroleum fractions. It was necessary to use both nomograms in order to cover the desired ranges of boiling point and flash temperature. This presented difficulties as the temperature scales of these two nomograms did not overlap, the highest temperature on Hadden's Figure 1 being the same as the lowest temperature on Hadden's Figure 2, namely 500° F. Readings made on both nomograms for the same component at 500° F are not in exact agreement as can be seen by Table 15.1, but this is not considered a serious objection as the values of α were smoothed in this temperature range.

The comparison shown in Table 15.1 could only be made at 500° F as this was the only temperature the two nomograms had in common. Since Hadden's Figure 1 was developed for lower boiling components while his Figure 2 was developed for higher boiling components, the values obtained from his Figure 1 should be more reliable for components boiling below the reference component while values obtained from his Figure 2 should be more reliable for components boiling above the reference component.

In addition to the fact that the temperature scales of the two Hadden nomograms did not overlap, another difficulty in using K values from this source[39] in developing the relative volatility correlation was the fact that there were only a few components in common to both charts. These two difficulties were resolved by the selection of the reference components plus cross plotting to smooth and extrapolate the values obtained from the nomograms.

A cross plot of the K values for the reference component (350° F atm. BP) vs temperature for lines of constant pressure, made with readings from both of Hadden's nomograms, shows smooth and regular curves with all readings falling on the curves except those at 450° F, 500° F, and 550° F, the values at 500° F falling above and below the curve. It appears that smoothed values of K, falling between the readings from Hadden's two nomograms, should be used in this temperature range.

In addition to this smoothing in the vicinity of 500° F, it was necessary to do some extrapolating in preparing Figure 15.5, the relative volatility correlation. This extrapolation was required to get α values for the more volatile components (i.e., between 100° F and 350° F atm. BP) at the higher flashing temperatures (i.e., 500° F and 900° F) and also the values for the less volatile components (i.e., between 350° F and 600° F atm. BP) at the low flashing temperatures (i.e., 150° F to 500° F). This extrapolation was made on log α vs at-

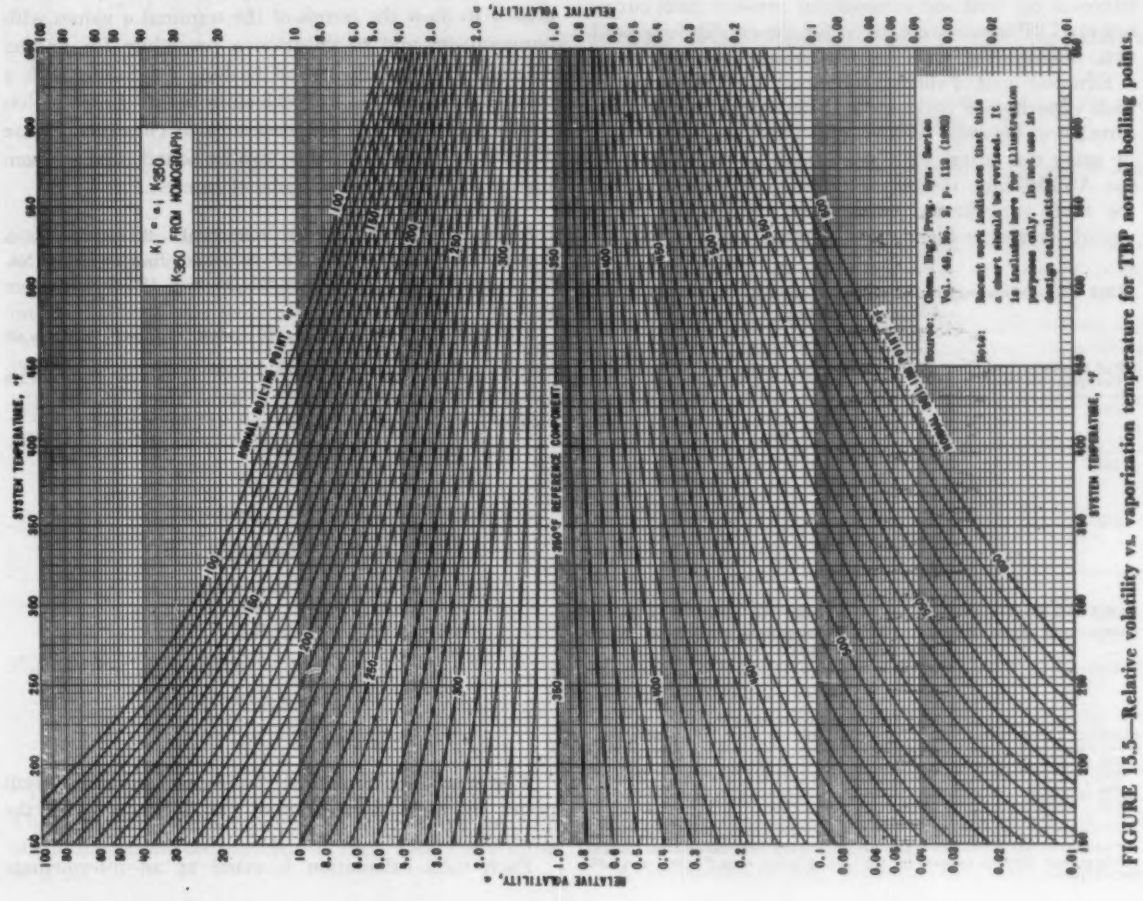

RELATIVE VOLATILITY, α
SYSTEM TEMPERATURE, °F
$K_i = \alpha_i K_{350}$
K_{350} FROM NOMOGRAPH
NORMAL BOILING POINT, °F
350° F REFERENCE COMPONENT
Source: Chem. Eng. Prog. Symp. Series Vol. 48, No. 2, p. 118 (1952)
Note: Recent work indicates that this a chart should be revised. It is included here for illustration purposes only. Do not use in design calculations.

FIGURE 15.5—Relative volatility vs. vaporization temperature for TBP normal boiling points.

mospheric boiling point scales with lines of constant flashing temperature; in other words, cross plots of Figure 15.5, which were made simultaneously with the preparation of Figure 15.5.

The K values of the reference component for the values in Figure 15.5 are not presented yet because (a) they are not required in the calculation method developed up to this point and (b) although satisfied with the α correlation developed from Hadden's nomograms, the author is not satisfied with the K values for the 350° F atm. BP component from this source. The comparison in Table 15.2 shows that K from Hadden's nomograms are lower than those from White and Brown.

How to Predict Vapor and Liquid Equilibrium. The proposed method for estimating TBP curves of equilibrium vapors and liquids has been applied to three flash vaporizations for each of two stocks. In these applications Equations (15.7a) and (15.7b) are used directly rather than the charts (i.e., Figures 15.1 through 15.4). Sample calculations are included for one stock and comparisons with observed TBP curves are given. Figures 15.6, 15.7, and 15.8 illustrate the calculations given in text and summarized in Table 15.3.

Complete experimental data, suitable for testing the proposed method, are almost nonexistent. The early work of Piroomov and Beiswenger[31] presented TBP curves of the feed and atmospheric pressure flash curves, but no TBP assays were given for the equilibrium products. Subsequent works have been similarly incomplete.

Edmister and Pollock[10] obtained ASTM assays on flash vaporization products and developed an empirical correlation between ASTM and TBP from other data. By using the latter, TBP assays may be estimated from the ASTM's for the vapor and liquid products from the flash vaporization experiments. Stock No. 27, a naphtha-kerosene blend, was selected from this source for these illustrative calculations because a complete TBP curve for the feed was available.

The other petroleum fraction used in these calculations is a gasoline-heavy naphtha stock on which complete data were obtained from Shell Development Company.[41] These data included TBP assays on the feed and products from three equilibrium flash vaporizations and the conditions for the flash separations. These Shell data are the best of the two sets used. The plots and sample calculations for Stock No. 27 are presented below.

Terminal values of α at various flashing temperatures were found for Stock No. 27 by the graphical operations shown in Figures 15.6 and 15.7. On Figure 15.6, α values for three flashing temperatures are plotted against the TBP liquid volume percent off for this stock on semilog graph paper. The α values for this plot were obtained from Figure 15.5 using the temperatures from the feed TBP assay as the component identification.

Average straight lines were drawn through these points and extended to the 0% and 100% limits, thus establishing the values of α_i and α_e for this stock at these three temperatures.

On Figure 15.7, these values α_i and α_e are plotted against temperature on semilog scales. This plot is included to show the trends of the terminal α values with temperatures and to illustrate a procedure for finding α_i and α_e values for several flashing conditions with a minimum of effort. For calculations at three or less flash conditions it is not necessary to construct Figure 15.7, as values of α_i and α_e can be found directly from Figure 15.6 for the conditions of interest.

Sample Calculation: Actual numerical calculations for a single point on each of the TBP curves for flashing Stock No. 27 at 400° F and 50 lb/sq.in.abs. to give 19.9% vapor are presented below:

The following calculations are independent of location on TBP:

The terminal values of α for the 400° F line on Figure 15.6 are $\alpha_i = 13.5$ at 0% and $\alpha_e = 0.035$ at 100% distilled. Calculations via Equations (15.7a) and (15.7b) follow:

$$\alpha_i/\alpha_e = \frac{13.5}{0.035} = 385.8$$

$$(\alpha_i/\alpha_e - 1) = 384.8$$

$$(\alpha_i/\alpha_e)^V = (385.8)^{1.099} = 3.27$$

$$(\alpha_i/\alpha_e)^V - 1 = 2.27$$

$$(\alpha_i/\alpha_e) - (\alpha_i/\alpha_e)^V = 382.5$$

$$\log \alpha_i/\alpha_e = 2.5862$$

$$V \log \alpha_i/\alpha_e = 0.5145$$

$$(1 - V) \log \alpha_i/\alpha_e = 2.071$$

The preceding numerical values are used at different points in the computations of the TBP curves of the products from that of the feed.

Each such calculation is made at an intermediate

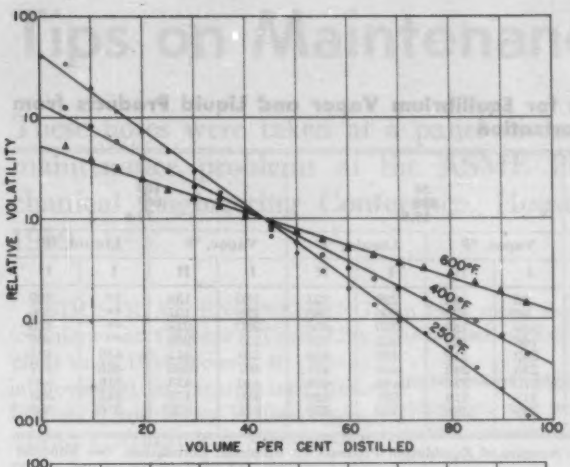
TABLE 15.1—Comparison of K Values at 500° F from Hadden's (39) Nomograms

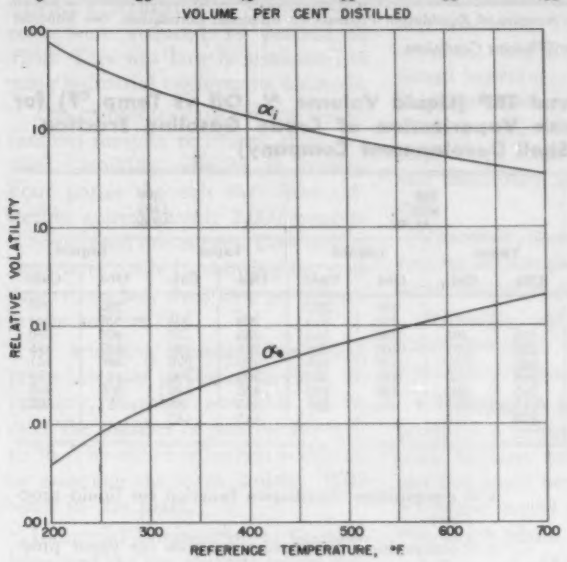
BP of Hypothetical Component, °F	Pressure, Psia	Hadden's Figure 1 K = y/x	Hadden's Figure 2 K = y/x
150	14.7	20.0	21.0
	100	3.5	3.2
	300	1.3	1.4
250	14.7	9.0	10.0
	100	1.55	1.5
	300	0.56	0.65
350	14.7	3.3	4.3
	100	0.57	0.66
	300	0.20	0.286

TABLE 15.2—Comparison of K Values for 350° F ATM BP Component from Hadden (39) Nomograms and from White and Brown (40)

Flashing Temperature, °F	K = y/x at 200 Lb./Sq. In. Abs.	
	White and Brown (40)	Hadden (39)
500	0.42	0.36*
600	0.90	0.70
700	1.6	1.2
800	1.9	1.75

* Smoothed value for better agreement between two nomograms. Actual readings from Hadden's charts for the point are 0.31 from Figure 1 and 0.38 from Figure 2.





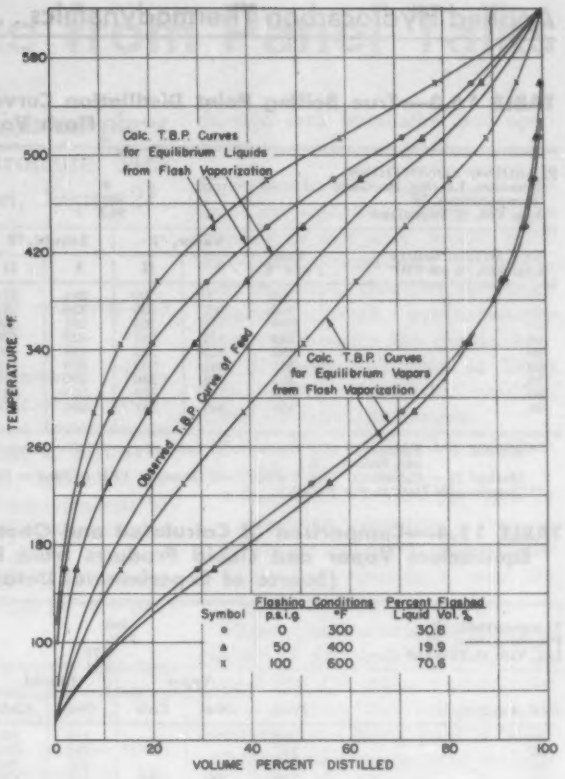


FIGURE 15.6—TBP volatility curves (top left) for the stock used in sample calculations.

FIGURE 15.7—Terminal relative volatilities (left) of the petroleum stock used in sample calculations.

FIGURE 15.8—Sample TBP curves (above) for a feed and its flashed products under three different conditions.

value of α (i.e., between α_i and α_e) so that the result is to find the percentages on the TBP curves of vapor and liquid products in terms of the corresponding percentage on the TBP of the feed, all percentages being at the same TBP assay temperatures, which only enters the operations in plotting the results after the calculations.

These calculations will be made to find the percentage on TBP's of vapor and liquid corresponding to 30% off on the feed TBP.

$$W_F = 1.0 - 0.3 = 0.7$$

$$\log \alpha/\alpha_e = (0.7)\ (2.5862) = 1.81$$

$$\alpha/\alpha_e = 64.55$$

$$\alpha/\alpha_e\ [\alpha_i/\alpha_e) - 1] = 64.55 \times 384.8 = 24{,}820$$

$$\alpha/\alpha_e\ [\alpha_i/\alpha_e)^V - 1] = 64.55 \times 2.27 = 146.5$$

Substituting in Equation (15.7b)

$$W_V = \frac{\log \dfrac{146.5 + 382.5}{384.8}}{0.5145} = 0.27$$

Equivalent percent off = 100 (1.0 — 0.27) = 73%

The TBP assay of the equilibrium vapor will show 73% off at the same temperature the feed TBP assay shows 30% off.

It is of interest to note that liquid volume quantities have been used. In this calculation any units (moles, pounds, gallons, etc.) may be used as long as all calculations are consistent and only TBP transformations are involved. In other words, calculations starting with a volumetric TBP and using liquid volume fractions flash vaporized will give volumetric TBP curves for the equilibrium vapor and liquids.

Substituting in Equation (15.7a)

$$W_L = \frac{\log \dfrac{24{,}820}{146.5 + 382.5}}{2.071} = 0.81$$

Equivalent percent off = 100 (1.0 — 0.81) = 19%

The TBP assay of the equilibrium liquid will show 19% off at the same temperature the feed TBP assey shows 30% off.

From the results of these and similar calculations, the TBP curves of vapor and liquid products may be plotted. Calculations of this kind were made for three separations of this stock and the results plotted in Figure 15.8. The TBP curves are given in Figure 15.8 for the feed and the products from these three separations.

A comparison of these product TBP curves with those

TABLE 15.3—True Boiling Point Distillation Curves for Equilibrium Vapor and Liquid Products from Flash Vaporization

FLASHING CONDITIONS Pressure, Lb./Sq. In. Gage Temperature, °F Liq. Vol. % Vaporized		0 300 30.8				50 400 19.9				100 600 70.6			
		Vapor, °F		Liquid, °F		Vapor, °F		Liquid, °F		Vapor, °F		Liquid, °F	
EFV Stream Source* Liq. Vol. % on TBP	Feed obs °F	I	II	I	II	I	II	I	II	I	II	I	II
10	160	70	90	281	274	60	86	226	221	130	138	**	309
20	230	107	130	334	344	93	123	296	293	198	197	**	386
30	289	146	163	391	390	129	153	350	350	260	248	**	430
40	344	174	183	423	428	166	182	393	397	311	295	**	467
50	396	212	222	448	460	202	212	436	438	359	341	446	495
60	441	241	252	479	487	235	242	466	471	407	386	485	517
70	481	276	286	506	511	270	276	496	498	446	433	516	540
80	513	315	326	520	538	313	319	521	529	480	475	542	563
90	559	369	381	560	576	369	386	550	570	518	522	576	589

* Method I — Estimated TBP Curves from Laboratory ASTM. Assays on Samples of Equilibrium Products by Empirical Correlation. See Edmister and Pollock (10.)
Method II — Calculated TBP Curves from Observed TBP of Feed at Given Flashing Conditions.
** Questionable Data in this Range.

TABLE 15.4—Comparison of Calculated and Observed TBP (Liquid Volume % Off vs Temp °F) for Equilibrium Vapor and Liquid Products from Flash Vaporization of Crude Gasoline Fraction (Source of Experimental Data: Shell Development Company)

Temperature, °F Pressure, mm Hg Liq. Vol. % Flashed		300 1316 8.77				300 632 31.98				400 1434 52.06			
		Vapor		Liquid		Vapor		Liquid		Vapor		Liquid	
TBP, Percent	Feed	Obs	Calc	Obs	Calc	Obs	Calc	Obs	Calc	Obs	Calc	Obs	Calc
10	202	....	....	218	216	....	....	260	263	....	....	292	287
20	241	....	....	255	256	....	....	312	313	209	208	350	344
30	276	....	....	293	294	210	205	350	354	235	232	405	390
40	316	190	200	337	336	230	221	400	391	247	252	437	425
50	361	208	214	385	379	240	239	430	425	270	276	460	451
60	407	230	228	425	420	265	260	460	453	305	306	475	475
70	448	240	245	440	455	285	283	480	480	336	342	500	496
80	483	270	270	495	488	315	315	505	507	385	386	527	522
90	527	312	315	535	531	370	370	....	....	445	445	....	....

estimated from observed ASTM's by empirical correlations[10] is given in Table 15.3 and does not prove or disprove the proposed method as ASTM assays are uncertain at best.

Similar computations were made for the Shell[41] heavy gasoline fraction. The details of these calculations are omitted because the procedures are exactly the same as the above calculations for Stock No. 27. The results are presented in Table 15.4 along with the observed TBP curves of the products. This comparison shows good agreement of calculated with observed TBP curves.

Parts 15a and 15b are based largely on two papers, by Professor Edmister and Dr. J. R. Bowman, which were presented before AIChE meetings and published in the Chem. Eng. Prog. Symposium Series [Volume 48, No. 2, 112 and No. 3, 46 (1952)]. This material, with considerable changes, is being presented here for completeness. In Part 16 the author will give additional material on this calculation method.

NOMENCLATURE

W_F = fraction of the charge remaining in the still pot of a TBP distillation assay of the feed

W_L = fraction of the charge remaining in the still pot of a TBP distillation assay for liquid product

W_V = fraction of the charge remaining in the still pot of a TBP distillation assay for vapor product

x_F = composition distribution function for the feed

x = composition distribution function for liquid product

y = composition distribution function for vapor product

$K_r = y/x$ = vapor-liquid equilibrium distribution ratio for reference component

α = relative volatility (referred to 350° F normal boiling point component); considered a function of boiling point and flash vaporization temperatures

α_i = same, at initial point, i.e., 0%, distilled in TBP assay

α_e = same, at end point, i.e., 100% distilled in TBP assay

$r_\alpha = \alpha_i/\alpha_e$ = ratio of terminal α values

I = a constant for each set of flashing conditions (i.e., pressure, temperature, amount flashed, and feed stock), introduced initially as a mathematical abbreviation and later eliminated in derivations of equations for the TBP assays of equilibrium products

M_L = moles/100 gallons of liquid fraction

M_V = moles/100 gallons of vapor fraction

LITERATURE CITED

1 through 37 (See Part 12).
[38] is at end of Part 14.
[39] Hadden, S. T., Chem. Eng. Prog. 44, 37 (1948).
[40] White, R. R., and Brown, G. G., Ind. Eng. Chem. 34, 1162 (1942).
[41] Souders, M., Jr., Shell Development Company, Private Communication, January 1950.

(PART 15b WILL APPEAR NEXT MONTH)

Tips on Maintenance from Panel Talks

These notes were taken at a panel discussion on plant maintenance problems at the ASME Petroleum Mechanical Engineering Conference, Houston, Sept. 21, 1959

INDUSTRIAL ENGINEERING techniques at Carbide's Texas City plant since 1954 shows a 40 percent improvement in maintenance performance, said Harry Walker, maintenance superintendent. Maintenance costs were reduced 10 percent in 1958. This was largely attributed to using industrial engineering methods.

The technique calls for the use of random samples recording three actions: working, idle or in transit. Four passes through the plant collecting approximately 2,000 samples is considered one survey. Cost reductions were made by showing the area supervisors how their men performed in the surveys.

By adopting standard tools and procedures for janitorial services, for example, Carbide was able to reduce the number of janitors from 77 to 36. The entire reduction was done by assigning the extra janitors other work in the plant.

Industrial Engineering at Carbide improved the use of plant trucks and vehicles to the tune of a $37,000 annual saving.

Pump and Turbine Maintenance. "If you have pump troubles, check first to see if the pump is operating at its design conditions," said one refiner. "This is the main cause of most pump maintenance problems."

Mechanical Seals. "The operators should notify the Maintenance Department at the first sign of seal trouble. Most often, they have no chance to check it before it goes out. So the damaged seal is replaced with a new one only to fail again."

Turbine Piping. Be sure to match mark mating pipe flanges when disassembling a row of turbines. The reason is that few pieces of piping are exactly the same and the marking will assure you an easy job of reassembly.

Turbines. One refiner reported very good luck using 140 S.A.E. oil in high speed turbine couplings and have had no failures.

Instrument Maintenance. Thirty years ago, one percent of the plant's capital investment in instrumentation was high. Today, 10 percent is common, said R. K. Schmoyer, assistant instrument superintendent, at Du Pont's Orange, Texas, plant. Instrument reliability for a series of instruments must often be 99 percent and sometimes as high as 99.9 percent.

Therefore, there is a very high operating burden placed on the Instrument Maintenance Department.

Schmoyer reported on the four-point program developed for Du Pont's Instrument Department:

- **Training.** A multi-skill approach produces a better man for the company because he is more efficient and has much better job satisfaction. Schmoyer noted that Du Pont is a non-union plant.
- **Preventive Maintenance.** The cost of preventive maintenance vs breakdown maintenance is a standoff until you add production loss. This is where preventive maintenance pays for itself. Du Pont uses a three phase system of preventive maintenance: inspection, (weekly), calibration (2-4 times yearly) and overhall (scheduled annually).
- **Scheduling and Records.** In scheduling instrument maintenance, records are essential because feedback is necessary to properly schedule the work. Du Pont uses a punch card system for scheduling which requires several hours of computer time each month. When work is performed on a piece of equipment, the mechanic completes a field history card which is later converted to punch card information.
- **Engineered Maintenance.** This type of engineering starts by working with the manufacturer to develop new instruments and carries through their installation and operation.

Shift work. Management, at one time or another, must decide whether or not they should place maintenance workers on a permanent shift basis. However, concluded Leonard Schwab, maintenance superintendent for the plastic devision of Monsanto's plant at Texas City, there are three basic considerations for shift maintenance:

- Premium payment for overtime work
- Production losses for lack of speedy maintenance
- Limited equipment and facilities available, creating a need for additional shifts.

These considerations are quite obviously all economic in nature. In many cases, the major consideration is the premium time being paid. If premium time being paid is high; and if overtime seems to be the rule rather than the exception; then you should consider shift maintenance work.

This following simple analysis will help you determine whether or not you can justify certain numbers of people on shifts.

First: Gather data on overtime hours worked by shifts and crafts for each day over a past period of time. The data used should be that which excludes a period of abnormally high or peak overtime. What you must use is a normal or average period—and this period should cover a month or two. Now, what must be determined is the cost savings if a certain number of craft personnel would have been on shifts during this typical or normal period selected.

This can be done by plotting a cost-saving curve against plotted numbers of craft personnel. First reduce past overtime data into *man-shifts* worked for each day for a given shift (i.e. manhours divided by eight). Then find the excess hours that would have been paid for each number of men on that shift. In other words, plot what would have been saved in premium time for each group of craftsmen for that shift.

The savings curve is the straight-

time cost of excess hours subtracted from the premium cost for the number of men.

The highest point reached by this curve represents the approximate savings that would have been realized if the optimum number of men were on that shift. The merits of this simple method would vary with each individual case, but generally it serves as a fairly accurate means of determining shift manpower.

This same method can be used, in part, to regulate or adjust established shifts.

There are disadvantages to shift maintenance which should be considered. Included are these:

- Inefficiency caused by lack of proper supervision. Low productivity can and will result from inadequate supervision.
- Inefficiency caused by lack of planning work to maintain the working manhours available. Assuming the shift is established primarily to cover emergency cases, care must be taken to provide fill-in work for any given shift.

In order to gain the maximum benefit from shift work, the number of persons per shift should be flexible. Careful adjustments in number of shift personnel both upward and downward can be a factor in cost-savings.

In many cases, the required number of shift personnel is much less on weekends than during the week. So schedule your craft work to balance this off-period load. Where shift schedules are union negotiated, emphasize the need of using various schedules so you can maintain logical staffing of shifts.

The thing to recognize is that shift maintenance *can* save money and that shift work can be evaluated economically.

Area Maintenance. Shell Chemical's Houston plant uses a system they call Area-Planned maintenance, according to C. W. Delong, technical manager of the Plastics and Resins Division.

The plant is divided into five areas each with its own area engineer having full authority over maintenance in his area.

The areas are subdivided into zones with zone foreman reporting to a zone supervisor who in turn reports to the area engineers. Technical assistance is given the area supervisors by maintenance engineers.

Delong said, "the success of area maintenance depends on designing the system to anticipate future plant expansion."

Ultrasonic Tester. Larry White, maintenance engineer with Spencer Chemical Company's polyethylene plant at Orange, Texas, described the use of ultrasonic testers. He said that they work very well on cylinders with carbide liners.

White described an incident in the plant in which the polyethylene decomposed forming a high pressure gas in the reactor. Unfortunately, the reactor relief valve failed to work properly. The maintenance department was concerned about stress cracks that may have formed in the reactor. An ultrasonic tester check showed no cracks and the reactor was back on stream in short order.

Area vs Centralized Maintenance. Whether or not you are unionized makes a big difference in the type of maintenance system you may have. Then again, is it a "craft" or "industrial" type union with which you must deal? Geographical conditions also exercise their influence. A plant located 60 miles away from everything gears up its organization much more for self-sufficiency than one in or adjacent to a metropolitan center.

There is no one specific system which is recognized as being the ideal and which merely needs adjusting to size in order to be used for doing the maintenance job in every plant.

According to P. J. Gurklis, general superintendent of maintenance shops, Dow Chemical Co., Freeport, Texas, "Centralized maintenance is suitable for small and medium sized plants, but to get the job done in a large plant requires decentralization to a great extent, if not all the way."

Dow uses a combination of "area" and "centralized" set ups. This group takes care of about two-thirds, or at times three-quarters, of the total maintenance job; the rest is performed by contractors.

Plant A is divided into five zones and Plant B into seven. Where possible, geographical areas of zones are identical with major production groups such as: Magnesium Production, Polyhydric Chemicals, etc. Each zone is further divided into areas consisting of one or more production plants. Each area is supervised by an area foreman, who is responsible to the zone supervisor for maintenance work in his area. The zone supervisors at Plant A are responsible to the Plant A superintendent of zone maintenance.

Each area foreman supervises a composite group made up from three crafts—boilermakers, machinists and pipefitters. Their primary function is to take care of the routine maintenance. The zone maintenance organization also includes approximately 50 men of the same three crafts who are assigned to roving crews to help in taking care of work load fluctuations which are often appearing in all the zones. The use of contractors is Dow's indispensable resort for coping with the serious problems created by fluctuations in the maintenance work load.

The Central Shops, employing about 900 people, consist of three groups or sections, namely: electrical (including the instrument shops) yards and buildings (including the paint and carpenter shops, masons and insulators) and mechanical (includes the boiler shop, machine shop, pipe shop and heavy machinery repairs).

The boiler, pipe and machine shops confine their work to the shop proper. The other crafts carry on their work in their shops and the field. Their field work is performed by craftsmen assigned to zones and with roving field crews. All of these craftsmen are at all times under their own supervisors.

The objective of the zone system is to increase efficiency and effectiveness through a decentrailized organizational setup resulting in: (1) greater familiarity of craftsmen with the plants in which they work; (2) less delay in starting emergency jobs; (3) more flexibility in meeting manpower needs; (4) improved coordination of multiple craft jobs; and (5) stronger realization of the maintenance needs of a complex chemical plant. ##

Predict Octanes for Gasoline Blends

The final octane rating of a gasoline blend can be influenced greatly by the olefin concentration of the components. Here is a way to estimate the blend octane

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THE NON-LINEAR EFFECT of gasoline composition on octane ratings is of great importance in planning refinery operations. The correlation presented here deals with one important aspect of this problem: the prediction of *laboratory* octane ratings for blends. The only component properties required are the volume percent olefins and the octane rating for the given test method and TEL concentration. For best results, the components should have very low concentrations of sulfur and sulfur compounds.

The present correlation is a refinement of the one developed by Schoen and Mrstik,[1] who presented a graphical correlation for predicting octane ratings of binary blends from the octane ratings and olefin percentages for the two components. The present method uses the same variables but is more self-consistent and is directly applicable to multicomponent blends.

The assumptions made in the correlation are listed below. These assumptions are consistent with the results of Schoen and Mrstik, and give a satisfactory fit of the blending data used here.

- The shape of the plot of octane rating versus volume fraction of component 1 for mixtures of two given components is assumed to be uniquely determined by the octane difference, $R_1 - R_2$, and the olefin difference, $U_1 - U_2$, between the two components.
- The octane rating is assumed to be a linear function of the volume fraction of each component if all components present have the same olefin content.
- The octane rating, R_{mix}, of a two-component mixture is assumed to depend linearly on the octane ratings of the components used, if the volume fractions and olefin percentages of the first and second components present are fixed.
- Additivity of component volumes is assumed.

The mathematical form of the present correlation is derived from the above assumptions, with the added requirement that the predicted octane number of a given binary blend be unique. The test of uniqueness is to compare the predicted values of R_{mix}, for a given composition, obtained by using various sequences of component addition in the calculations (including the direct calculation in which all components are added in a single step). The present correlation meets this test exactly (within roundoff error) for binary blends, and

TABLE 1—The Weighting Factor D_i Computed From Equation (2)

P_I (Olefin Difference)	D_I Research Method	D_I Motor Method
—100	0.454	0.314
— 90	0.495	0.358
— 80	0.539	0.406
— 70	0.585	0.459
— 60	0.635	0.518
— 50	0.688	0.583
— 40	0.744	0.654
— 30	0.803	0.731
— 20	0.865	0.814
— 10	0.931	0.904
0	1.000	1.000
10	1.072	1.103
20	1.148	1.213
30	1.227	1.329
40	1.309	1.451
50	1.395	1.580
60	1.483	1.715
70	1.575	1.855
80	1.670	2.001
90	1.768	2.152
100	1.868	2.308

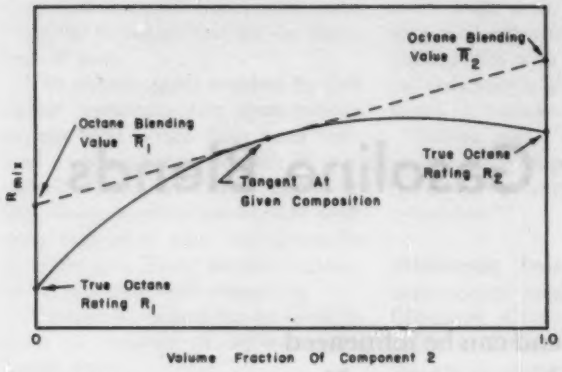

FIGURE 1—Small changes in gasoline composition can be studied easier by defining octane blending values.

within 0.1 octane unit for most multicomponent blends. The direct calculation is preferred because it is the shortest and, of course, gives only one possible result.

Working Equations

The octane rating of a blend of given composition is predicted by the equation

$$R_{mix} = \frac{\Sigma_i V_i D_i (R_i + CP_i)}{\Sigma_i V_i D_i} \quad (1)$$

where

V_i = Volume of component i added to blend.

P_i = Olefin difference, $U_i - U_{mix}$, volume percent.

D_i = A weighting factor, given by Table I or Equation (2). Note that D_i is a function of P_i *and* of the rating method considered.

R_i = Octane rating of component i by the given test method.

C = 0.130 for Research octanes (F-1) or 0.097 for Motor octanes (F-2).

The weighting factor D_i is given in Table 1. Rounding the D_i values to two decimal places will seldom change the calculated value of R_{mix} by more than 0.1 octane unit, which is within the correlation accuracy. For automatic computation, it is easier to develop D_i from the defining equation

$$D_i = \frac{AP_i}{1 - e^{-AP_i}} \quad (2)$$

$$= 1 + \frac{AP_i}{2} + \frac{(AP_i)^2}{12} - \frac{(AP_i)^4}{720} + \frac{(AP_i)^6}{30240} - \ldots \quad (2a)$$

where

A = 0.01414 for Research octanes or 0.01994 for Motor octanes.

The first four terms of Equation (2a) give D_i with a maximum possible error of —0.002, and this precision is generally adequate.

It is permissible to "back out" any component, k, from a blend by using a negative value of V_k; this procedure is useful when some components have been tested in blends rather than separately.

For studies of small changes in gasoline composition, it is convenient to use the differential expression

$$d(VR)_{mix} = \Sigma_i \overline{R}_i \, dV_i \quad (3)$$

where $\overline{R}_i$ is a blending octane value for component i, more explicitly defined as

$$\overline{R}_i = \left[\frac{\partial (VR)_{mix}}{\partial V_i}\right]_{V_j = \text{ constant for all } j \neq i} \quad (4)$$

This definition of $\overline{R}_i$ is similar to those used for partial molal quantities in thermodynamics.[2] The physical significance of $\overline{R}_i$ in binary blends where volumes are additive is illustrated in Figure 1, where $\overline{R}_1$ and $\overline{R}_2$ are obtained, for a given composition, by the method of tangent intercepts. This construction is not needed with the present correlation, however, since $\overline{R}_i$ can be directly evaluated from Equations (1) and (4), and the assumption of additive volumes, to give

$$\overline{R}_i = R_i + (D_i - 1)\,[R_i - R_{mix} + CP_i] \quad (5)$$

Equation (4) shows that, according to the present correlation, the blending octane value of any component depends only on the octane ratings and olefin percentages for the given component and blend.

Integration of Equation (3) at constant composition gives the equation

$$(VR)_{mix} = \Sigma_i V_i \overline{R}_i \quad (6)$$

or, if the volumes are additive in the mixture,

$$O = \Sigma_i V_i (\overline{R}_i - R_{mix}) \quad (7)$$

Equation (7) is used to determine gasoline compositions that will meet a given octane specification. Since the $\overline{R}_i$ values change but gradually with composition in most cases, the equation is nearly linear for small changes in composition. If U_{mix} is known or correctly estimated, Equation (7) gives a direct solution. The use of this equation is illustrated in Example II.

Changes in R_{mix} due to small changes in composition may be computed from Equation (3). Differentiation of the product in Equation (3) gives:

$$V_{mix}\, dR_{mix} + R_{mix}\, dV_{mix} = \Sigma_i \overline{R}_i dV_i \quad (8)$$

Using the assumption of additive volumes,

$$dV_{mix} = \Sigma_i \, dV_i \quad (9)$$

Combining Equations (8) and (9) gives

$$dR_{mix} = \frac{\Sigma_i (\overline{R}_i - \overline{R}_{mix}) dV_i}{V_{mix}} \qquad (10)$$

The use of this equation is illustrated in Example III.

Accuracy of the Correlation

The constants A and C of the correlation equations were fitted, by least-squares analysis, to data on 102 different blends of typical refinery streams. All but 10 of the blends were binary blends; the rest ranged from 3 to 6 components. Components used included straight-run fractions, polymer fractions, thermal and catalytic gasoline fractions, catalytic reformates, and alkylates. The data were weighted according to their estimated uncertainty, following the methods given by Deming.[3]

Table 2 shows the correlated results and deviations. The deviations were found to approximate a normal distribution for each of the test methods; thus about 68 percent of the deviations for the research method lie within one standard deviation, or ± 0.77 octanes, and the corresponding limits for the motor method are ± 0.64 octanes. These limits are believed typical of what one can expect in predicting refinery blends, with reasonable care in engine testing.

The deviations in Table 2 include the effects of experimental error and of error in the correlation. The latter error undoubtedly varies with the blend and component compositions; its root-mean-square value for these blends is estimated to be less than two-thirds of the standard deviations reported in Table 2. This estimate is based on a limited amount of reproducibility data; more accurate estimation of the correlation accuracy would be possible if duplicate tests had been made under representative conditions.

The correlation has not been adequately tested for blends in which narrow-boiling or highly aromatic stocks are used. The predicted results of adding or removing such stocks should therefore be viewed with caution, and checked experimentally, if possible.

TABLE 2—Summary of Results

	Research Method	Motor Method
Blending constant A	0.01414	0.01994
Uncertainty, σ_A	0.00081	0.00079
Blending constant C	0.130	0.097
Uncertainty, σ_C	0.025	0.006
Number of points		
Without TEL	94	98
With 3 ml/gal of TEL	93	94
TOTAL	187	192
Deviations, Observed R_{mix} minus Predicted R_{mix}		
Mean deviation	+ .03	+ .01
Standard deviation	.77	.64
Maximum deviations	−2.1	−2.1
	+2.3	+2.2

ILLUSTRATIVE EXAMPLES

Example I: Compute the research clear octane rating of the blend shown in Table 3.

TABLE 3—Example I

Component	V_i, Barrels	U_i, Vol. % olefins	R_i, Research Clear
1—Polymer	100	97.3	98.0
2—Reformate	100	0.9	82.0
3—Straight Run	100	0.4	66.0

Solution: Use Equation (1).

Step 1. First compute the volume percent olefins in the mixture:

$$U_{mix} = \frac{100(97.3) + 100(0.9) + 100(0.4)}{100 + 100 + 100} = 32.9 \text{ vol. \%}$$

Step 2. Calculate the olefin differences, $P_i = U_i - U_{mix}$:

$$P_1 = 97.3 - 32.9 = \ \ 64.4 \text{ vol. \%}$$
$$P_2 = \ 0.9 - 32.9 = -32.0 \text{ vol. \%}$$
$$P_3 = \ 0.4 - 32.9 = -32.5 \text{ vol. \%}$$

Step 3. Read the D_i values for the given test method from Table 1, and compute V_iD_i:

$$V_1D_1 = (100)(1.53) = 153$$
$$V_2D_2 = (100)(0.79) = \ 79$$
$$V_3D_3 = (100)(0.79) = \ 79$$

Step 4. Compute $R_i + CP_i$ for each component, where C = 0.130 for the Research method:

i	$R_i + CP_i$, Research clear
1	106.4
2	77.8
3	61.8

Step 5: Compute R_{mix} from Equation (1) and the results of Steps 3 and 4:

$$R_{mix} = \frac{153(106.4) + 79(77.8) + 79(61.8)}{153 + 79 + 79}$$
$$= 87.8 \text{ Research octane, clear}$$

R_{mix} could be calculated in the same manner for the Research method at any other TEL concentration if octane ratings were available for all components at the desired TEL concentration. Note that D_i and C are independent of TEL concentration. The procedure for Motor method octanes is the same except that the values of D_i and C differ from those for the Research method.

When more than one composition is to be studied, with a given set of components, the following rearrangement of Equation (1) is recommended:

$$R_{mix} = \frac{\Sigma_i V_i D_i r_i}{\Sigma_i V_i D_i} - CU_{mix} \qquad (11)$$

where

$$r_i = R_i + CU_i \qquad (12)$$

This gives the same numerical results as (1) but has the advantage that r_i does not vary with mixture com-

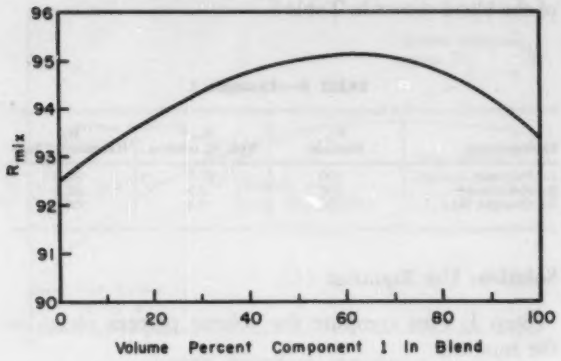

FIGURE 2—A range of compositions will fulfill the 95 Research octane specification given in Example II.

position, whereas $R_i + CP_i$ does. With this method, the above problem is solved as follows: Steps 1, 2 and 3 are the same as before.

Step 4. Compute $r_i = R_i + CU_i$ (if not already determined):

i	r_i
1	110.6
2	82.1
3	66.1

Step 5. Solve Equation (11) for R_{mix}:

$$R_{mix} = \frac{153(110.6) + 79(82.1) + 79(66.1)}{311} - 0.130(32.9)$$
$$= 92.1 - 4.3$$
$$= 87.8 \text{ Research octane, clear}$$

Example II—Can a 95-octane blend (Research method, with 3 ml/gal of TEL) be produced from the two components listed in Table 4? If so, determine the limits on the amount of component 1 that can be used.

TABLE 4—Example II

Component	V_i, Barrels	U_i, Vol. Percent	R_i, Research, 3 ml TEL/gal
1	Unlimited	0	93.4
2	1000	100	92.5

Solution: The shortest method for this simple problem is to compute R_{mix} from Equation (11) or (1) at various compositions and plot the results as shown in Figure 2. From the figure it is clear that the 95-octane specification can be met or exceeded over a considerable range of composition. The predicted limits on V_1 are:

Volume Percent of Component 1	V_1, barrels
71	2500 (maximum)
50	1000 (minimum)

From Figure 2 it is evident that these results are rather uncertain, due to the close approach to the predicted maximum value of R_{mix}, and experimental checks would be in order.

The possibility of producing a blend with a higher octane rating than any available component is a fact of considerable interest in present-day refining; it will be noted from this example that small octane differences and large olefin differences favor such a result.

Another approach is to use Equations (5) and (7), which provide an iterative solution similar to Newton's method. This method is faster for multicomponent problems, and is readily adapted to automatic computation. The procedure for the present problem is as follows:

Step 1. Assume a value of U_{mix}, say 0.0 vol. %

Step 2. Compute the olefin differences:

$$P_1 = U_1 - U_{mix} = 0.0 \text{ vol. \%}$$
$$P_2 = U_2 - U_{mix} = 100.0 \text{ vol. \%}$$

Step 3. Obtain D_i for the given test method from Table I or Equation (2):

$$D_1 = 1.00 \text{ (Research method)}$$
$$D_2 = 1.868 \text{ (Research method)}$$

Step 4. Compute $\bar{R}_i$ values from Equation (5):

$$\bar{R}_1 = 93.4 + (1.000 - 1)\,[93.4 - 95.0 + 0.130(0)]$$
$$= 93.40$$
$$\bar{R}_2 = 92.5 + (1.868 - 1)\,[92.5 - 95.0 + 0.130(100)]$$
$$= 101.61$$

Step 5. Solve Equation (7) for V_1:

$$O = V_1(93.40 - 95.0) + 1000(101.61 - 95.0)$$
$$V_1 = 4130 \text{ barrels}$$

Step 6. Recompute U_{mix}:

$$U_{mix} = \frac{4130(0) + 1000(100)}{4130 + 1000} = 24.2 \text{ vol. \%}$$

Step 7. Compare the new U_{mix} with the assumed value. If the values agree within 1 percent, the solution for V_1 is close enough; if not, repeat Steps 2-6 with the new U_{mix}.

Continuation of the above iteration procedure gives the rapidly converging results shown in Table 5.

TABLE 5—Solution to Example II

Iteration Number	Assumed U_{mix}, Vol. Percent	V_1, Barrels	New U_{mix}, Vol. Percent
1	0	4130	24.2
2	24.0	2560	28.1
3	28.0	2490	28.7
4	28.7	2490	28.7

Analogous calculations starting from $U_{mix} = 100$ converge with similar rapidity to the second limiting solution: $V_1 = 1000$ barrels.

Refinery problems generally involve many unknowns;

the procedure for solution is similar except for Step 5, which must be expanded to include any other operating restrictions and economic criteria that may be pertinent. Linear programming[4] and other mathematical optimization methods[5,6] have been applied to problems of this type; some applications of the present correlation to refinery blending problems are discussed in one of the references.[6] It appears that satisfactory solutions may be obtained for most refinery blending problems by using the iterative technique of this example in conjunction with linear programming; in fact, iteration becomes unnecessary if U_{mix} is correctly estimated.

If the given octane specification is impossible, the results of successive iterations will either oscillate wildly or converge to a solution in which some of the component volumes in Equation (7) are negative. Either situation is readily detected.

Example III. How much would the results of Example II be changed if the octane specification were increased by 0.1 unit?

Solution: The methods of Example II are applicable. For small changes, however, Equation (10) is easier to use. Noting that only V_1 is variable, Equation (10) becomes:

$$dR_{mix} = \frac{\bar{R}_1 - R_{mix}}{V_{mix}} dV_1 \qquad (13)$$

Assuming that the composition change will be small, this can be integrated approximately to give

$$\Delta V_1 \doteq \frac{V_{mix}}{\bar{R}_1 - R_{mix}} \Delta R_{mix} \qquad (14)$$

The conditions at the limits found in Example II are shown in Table 6.

TABLE 6—Limits by Example II

V_1	V_{mix}	U_{mix}	$\bar{R}_1$ from Equation (5)	R_{mix}
1000.....	2000	50.0	95.9	95.0
2490.....	3490	28.7	94.4	95.0

About the Author

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The changes in V_1 due to the increased octane requirement are given approximately by Equation (14):

Lower Limit:

$$\Delta V_1 \doteq \frac{2000}{95.9 - 95.0}(0.1) = 200 \text{ barrels}$$

$$V_1 \doteq 1000 + 200 = 1200 \text{ barrels}$$

Upper Limit:

$$\Delta V_1 \doteq \frac{3490}{94.4 - 95.0}(0.1) = -600 \text{ barrels}$$

$$V_1 \doteq 2490 - 600 \doteq 1900 \text{ barrels}$$

Summarizing the results of Examples II and III,

If $R_{mix} > 95.0$, then $1000 \leqslant V_1 \leqslant 2490$ barrels
If $R_{mix} > 95.1$, then $1200 \leqslant V_1 \leqslant 1900$ barrels

The rapid narrowing of the blending limits with increasing octane requirement indicates, in agreement with Figure 2, that we are approaching the maximum value of R_{mix} for the given components. It is evident that the limits of blend composition cannot be predicted very accurately under such conditions, even though the prediction of R_{mix} at a given composition may be quite accurate.

NOMENCLATURE

- A Numerical constant (see Equation 2).
- C Numerical constant (see Equation 1).
- D_i Weighting factor for component i (see Equation 2 and Table 1).
- P_i Olefin difference, U_i-U_{mix}, volume percent.
- R_i Octane rating of component i.
- $\bar{R}_i$ Blending octane value of component i (see Equations 3, 4, 5).
- R_{mix} Octane rating of total blend.
- U_i Volume percent unsaturates (olefins) in component i.
- U_{mix} Volume percent unsaturates in total blend.
- V_i Volume of component i added to blend.
- V_{mix} Volume of total blend.
- r_i Composite property of component i (see Equations 11, 12).
- Σ_i Summation over all components (all values of i).

ACKNOWLEDGMENT

The work reported here was done by the author at the Sinclair Research Laboratories. Special acknowledgment is due to W. F. Schoen, A. V. Mrstik, and L. N. Anderson for contributing the blend data, and to H. F. Hopp and the computer group for assistance with the statistical calculations.

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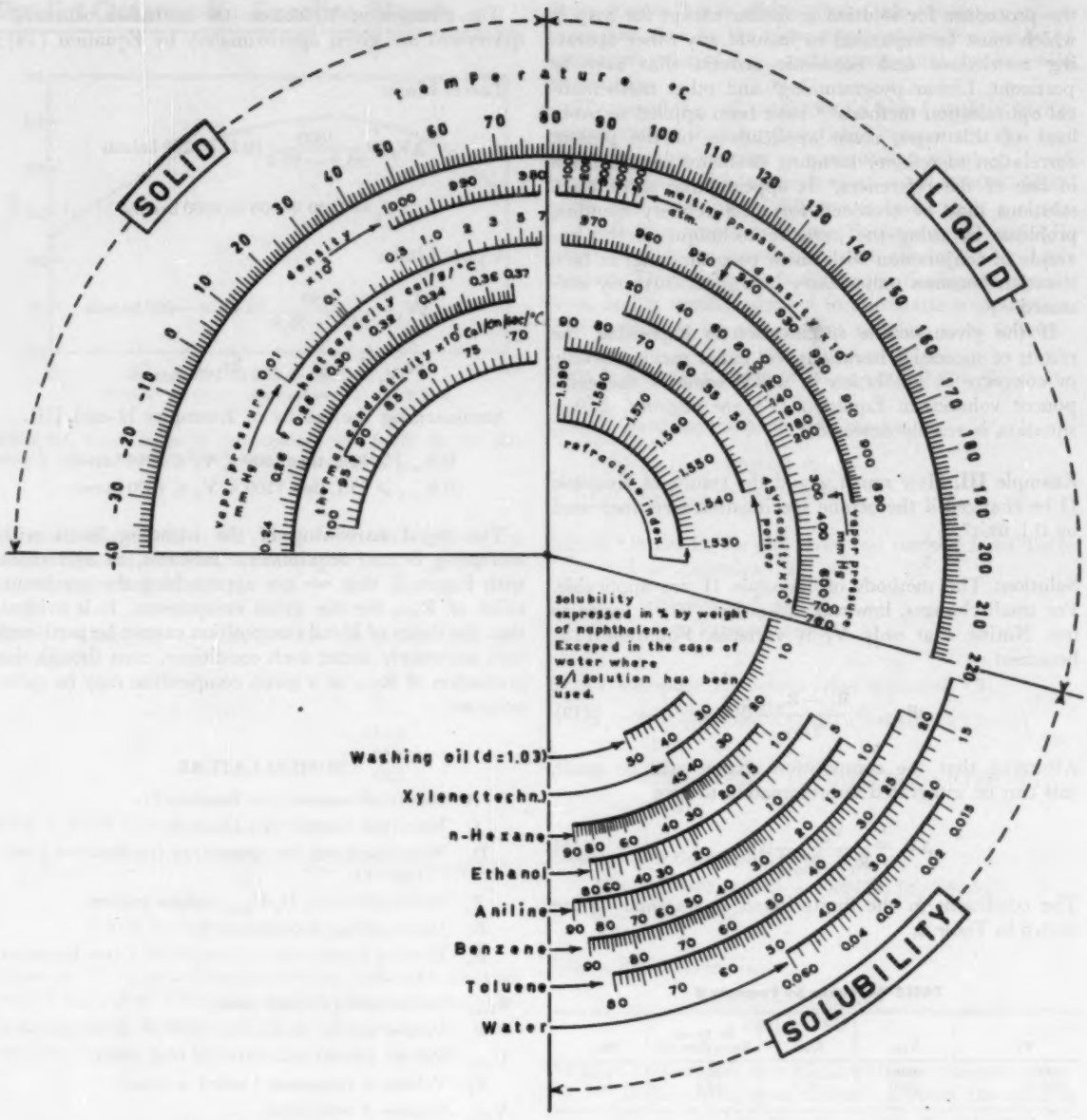

Physical Properties of Naphthalene

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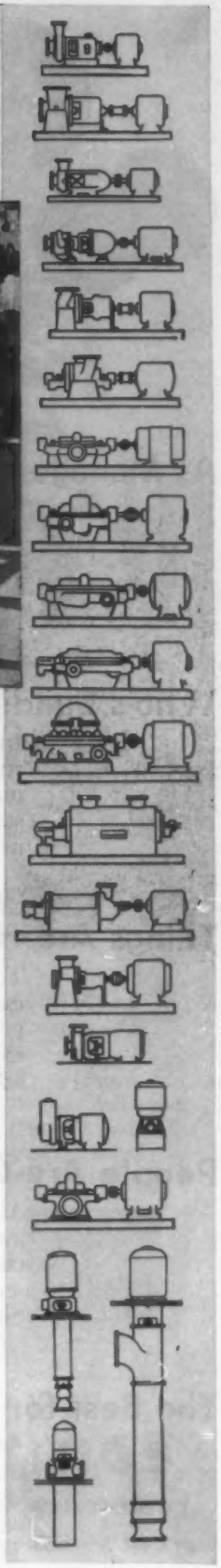
Staatsmijnen in Limburg
Geleen, Netherlands

THE ACCOMPANYING nomogram giving the physical properties of naphthalene, has been constructed from literature values. The nomogram has been divided into three sections: one for the solid and liquid state resp. and one for solutions of naphthalene in several solvents. This division divides the temperature scale into two parts: i.e., from —40 to 80° C (being the melting point) in which interval the properties of the solid and of the solution can be read off, and the part from 80 to 220° C where the properties of liquid naphthalene are given.

Any line passing through the center intersects the scales in corresponding points. The scale labled "melting pressure" (lying in the first quadrant) gives the melting point as a function of pressure e.g., it can be read off that at a pressure of 300 atm. the melting point of naphthalene amounts to 91° C. The use of circular scales has the advantage that in any position the nomogram is read off perpendicular to the scales. # #

HOW TO PICK A WINNER IN THE "OCTANE RACE"



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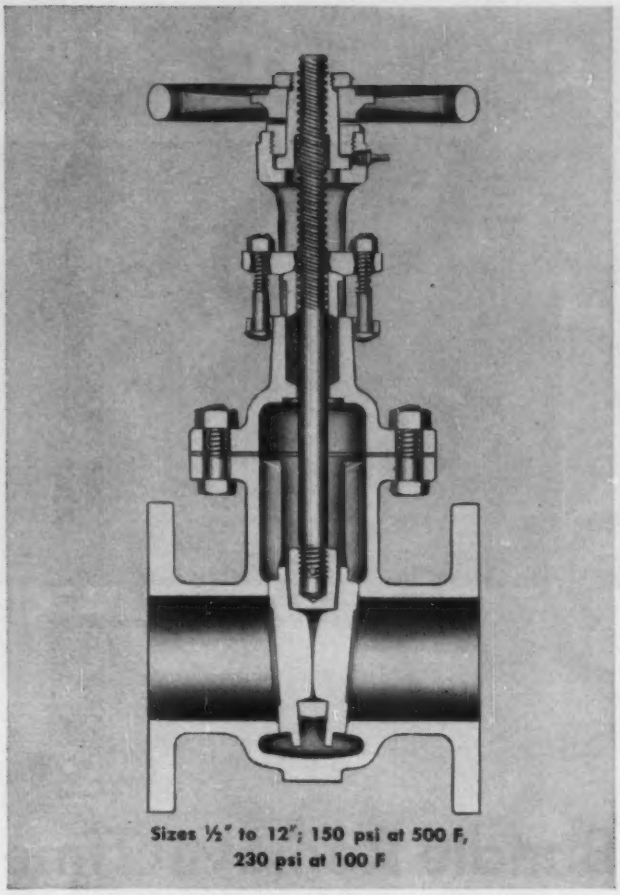
To make sure you're informed of major news developments in the Industry last month, read "What's Happening," a fast moving digest of the latest news about people, places and things in your field. It's just what the doctor ordered for busy men who don't have time to read long accounts of oil news. You'll see for yourself when you . . . **Keep going to page 190**

People Are Going Places

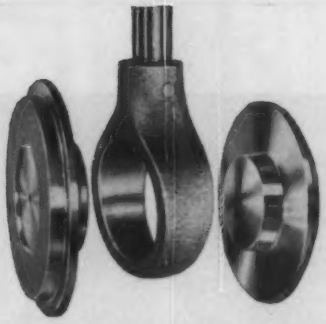
As the Industry progresses, new jobs are opened and old jobs are filled by new men. You may know many of those who have been promoted, transferred or changed jobs recently. Take a look at the "Men in Industry" Department to see what's happening to the men you know and those you would like to know. Simply . . . **Keep going to page 205**

The Best for Your Plant

As a man interested in doing what's most economically feasible to keep your plant modern and in top shape, you need to know the latest in equipment developments. The monthly REFINER feature, "New Equipment and Literature," will give you a quick rundown on the latest and best implements for your plant. To learn more . . . **Keep going to page 238**

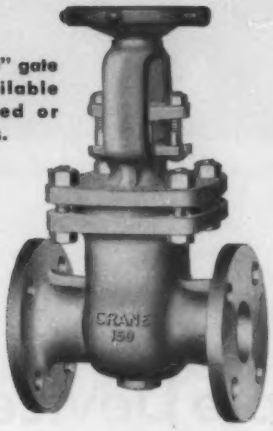


Sizes ½" to 12"; 150 psi at 500 F, 230 psi at 100 F



Crane split-wedge disc design. Identical disc halves assure uniform seating pressure.

"Craneloy 20" gate valve. Available with flanged or screwed ends.



Exclusive design for lasting tight seating in "Craneloy 20" gate valves

The simple, unique split-wedge disc construction in "Craneloy 20" gate valves is the key to smooth operation, tight shutoff and long seat life.

Identical disc halves, exclusive with Crane, mean that seating loads are transmitted equally to each half, assuring uniform pressure on the seating faces. No danger of buckling—there's no weak disc member as in conventional ball and socket disc construction. In opening, the first turn of the handwheel frees discs—even if the valve is closed hot and opened cold.

Special guide flanges on the discs, *another Crane extra*, prevent disc drag across the seat during operation . . . give you longer seat life. Discs are free to rotate to prevent seizing and galling.

All parts of the valve in contact with flow are "Craneloy 20," a high nickel, high chromium stainless steel cast in Crane's own foundries. Stuffing boxes are packed with tough, resilient, non-contaminating Teflon.

For complete information about all Crane stainless steel valves, see your Crane Representative.

Get complete specifications on "Craneloy 20" stainless steel valves. Ask your Crane Representative for Circular AD-2080, or write to address below.

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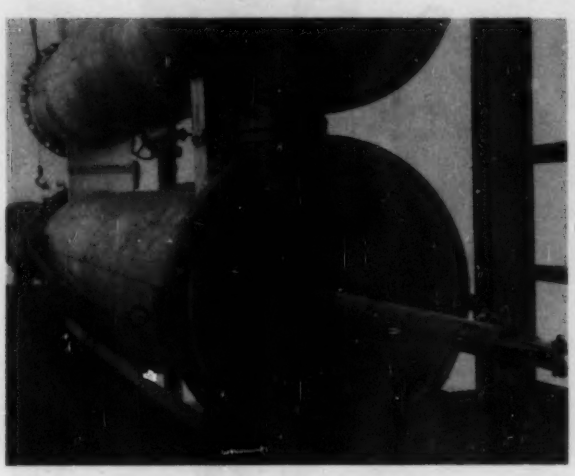
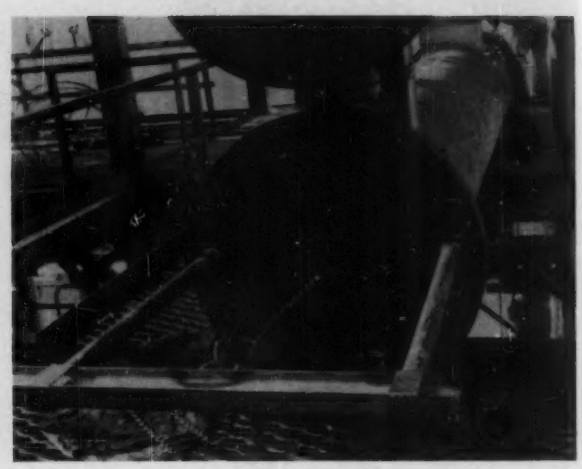
How to Do It...



Pusher pipe removes bundle . . .



. . . frame and chain fall replace it.

Simple Devices Cut Bundle Removal Time

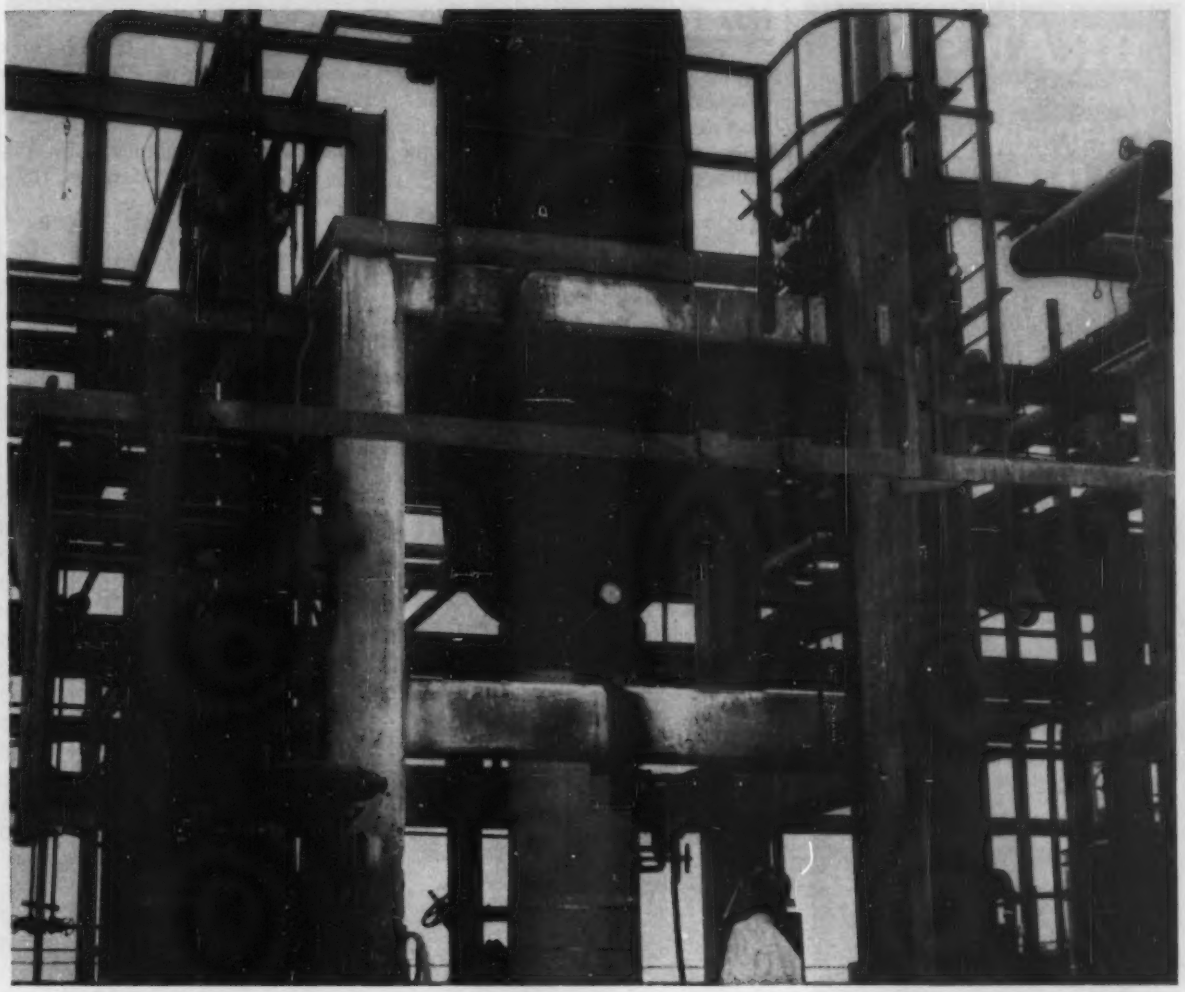
Are you having a rough time getting those tube bundles out of the shell? A simply designed pusher pipe and chain fall will let you remove them in 10-15 minutes

The pulling of exchanger bundles has probably produced more ideas for easier handling than all other pieces of process equipment. However, here is another trick of the trade used in an Italian plant.

The left photograph shows a device for removing the bundle. A pipe as long as the shell is welded to a flat plate which is cut to a suitable diameter. A pulley is welded to the other end of the pipe, as shown. An eye is bolted to the shell flange (right side of photo) and an eye screwed into a piece of angle which is bolted to the shell flange on the opposite side. By running a wire rope through the pulley and eye guide, and clamping it to a chain fall, the bundle can be pulled in a matter of 10-15 minutes. Because the chain fall has a limited travel, the cable clamp will necessarily require an adjustment during the pulling operation.

A rope attached to the overhead structure or piping is used to support the bundle-pushing pipe until the bundle is moved far enough out of the shell so that the pusher pipe will not tilt. (Note: See PETROLEUM REFINER's May 1959 issue, page 260 for ideas on handling the bundle after it is out of the shell).

The right photograph shows a method for replacing the bundle after it has been cleaned, repaired or retubed. A plate is welded to one end of a piece of pipe and drilled for bolting to the shell flange. A rectangular slide is welded to the other end of the pipe, as shown. Using a convenient length of structural steel to which is welded a large eye for at-



HF is recovered from a by-product stream and regenerated in this flash tower, following alkylation. Lukens 20% Monel-Clad Steel provides excellent resistance to attack by HF-acid over its entire concentration range. Vessel operates at 260°F and 165 psi. It is 3½ feet in diameter and 13 feet high. Shell is ⅜ inch thick.

After 10 years of regenerating HF-acid...

Monel-clad tower is still a tower of strength

This Monel*-clad flash tower has been regenerating spent HF-acid since August, 1949. It is in service at the Mobil Oil Company's Paulsboro, New Jersey refinery.

It's still in excellent condition. And many more years of use are expected of it.

Mobil's corrosion engineers chose Monel alloy cladding because of its outstanding resistance to attack by HF. The tower handles the entire concentration range, from anhydrous HF to the azeotropic 62% H_2O-38% HF mixture, at widely varying velocities. Temperature is of the order of 260°F.

Among the other important factors in Mobil's selection of Monel-clad steel were its high strength... the ease with which it can be fabricated and welded...and its ready availability, often right from warehouse stocks.

For assistance in the selection of materials for your HF alkylation unit and other refinery equipment, contact us. Our engineers will gladly provide the metallurgical information you want.

*Inco trademark

JUST OFF THE PRESS. Is sulfuric acid giving you trouble in other areas of your refinery? Here's a technical booklet on recently-developed Ni-o-nel* alloy that may offer a happy solution. Ni-o-nel alloy resists attack by sulfuric acid and a number of other severely-corrosive acids and oxidizing chemicals, over a wide concentration and temperature range. For details, write for a free copy of "Engineering Properties of NI-O-NEL."

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VIDIGAGE® 14 — the high-accuracy, high-speed, ultra-sensitive gage with a 14" CR tube. Range 0.005" to 2.7" with accuracies to 1/10 of 1%. Interchangeable oscillators and direct-reading scales. Extension cables and intercom phones for remote testing up to one-fifth mile from the basic instrument. **BULLETIN V-200.**

SONORAY® 5—the new portable, high-performance pulse-echo Flaw Detector for testing weldments, shafts, plates, etc., and detecting other internal flaws. Only 37 lbs., 7½" x 11" x 20¼" long. **BULLETIN T-203.**

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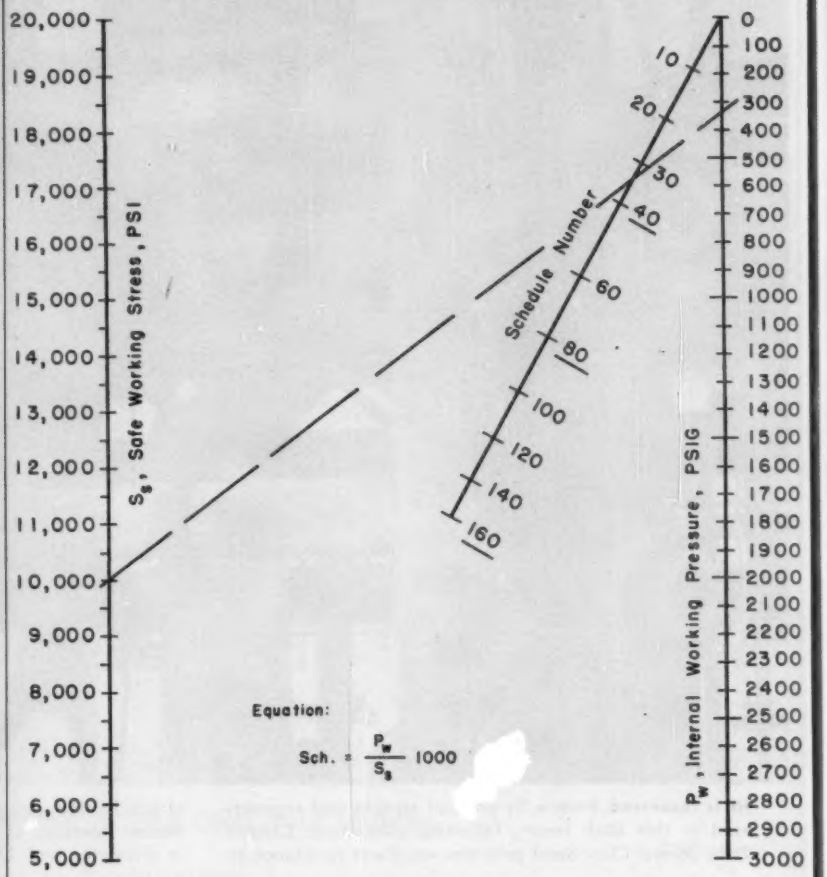
How To Do It . . .

taching a chain fall hook, an adjustable bundle puller can be made. An eye bolt is screwed into the tube sheet, a chain fall attached and the pulling operation begins.

This latter device can also be used as an assist to the bundle pusher for those stubborn bundles that are hard to break out.

This idea was submitted by Vittorio Amato, I.C.I.P, Mantova, Italy.



It's Easy To Find Pipe Schedule Number

In the past, in order to designate the pipe thickness, the terms standard, extra strong, and double extra strong were in common use. Presently, however, the use of the schedule number is preferred to designate pipe thickness, as modern industrial demands for more exact specifications have made the old designation obsolete.

The pipe "schedule number" as designated by the American Standards Association is an approximation of the following expression:

$$\text{Schedule Number} = \frac{P_W}{S_s} 1000 \qquad (1)$$

where:

P_W = internal working pressure, psig.
S_s = safe or allowable working stress, psi.

This expression is based on the actual formula used for estimating the required pipe thickness.

$$t = \frac{P_W D}{2S_s} + C \qquad (2)$$

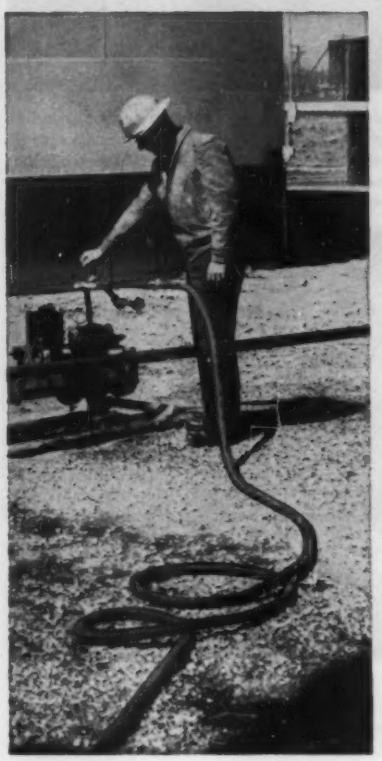
where: D = outside diameter of pipe, in.
t = thickness of pipe, in.
C = corrosion allowance, in.

The values of the allowable stress at various temperatures are given in various references for the various materials of construction.[1,2]

Sizes through 10 inches in schedule 40 are equivalent to standard weight, and sizes up to 8 inches in schedule

MATCHLESS #5 STEAM HOSE

3 Men . . . 3 Applications
One Hose



Safety
U.S. Matchless #5 Steam Hose has been used at a Phillips Petroleum refinery* since 1930, for thawing and firefighting.

Easy Handling
Here U.S. Matchless #5 is being used to remove spilled oil.

Economy
Warehouse boss at Phillips Petroleum inspecting a length of U.S. Rubber Matchless #5 Steam Hose.

Men like to work with U.S. Matchless® #5 because it's so lightweight, so flexible. Ordinary hose is hard to handle, can't take much dragging around. But the hose that's readily available, lasts longer, and satisfies the operators is the best investment. That's U.S. Matchless.
When you think of rubber, think of your "U.S." Distributor. He's the best on-the-spot source of technical aid, quick delivery, and industrial rubber products.

*Okmulgee, Okla.

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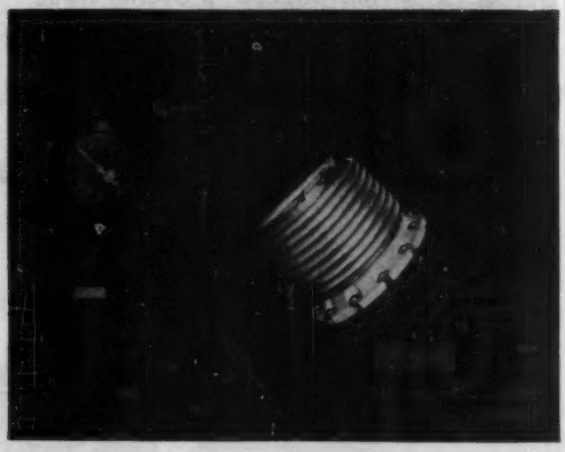
4 WAYS to get maximum reliability in expansion joints

1 Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



2 Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.

3 Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

4 Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

At Zallea, none of the many factors affecting expansion joint reliability are left to guesswork . . . including the four vital ones above.

This is reflected in these facts. Zallea material specifications are the most exacting in the industry. Zallea expansion joints are hydraulically formed. Zallea advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers more application engineering experience.

For all the facts, write for Catalog 56. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

Zallea for maximum reliability

ZALLEA BROTHERS, Wilmington 99, Delaware • World's largest manufacturer of expansion joints

How To Do It . . .

80 are the same as the previous extra strong designation. The double extra strong designation is not equivalent to any specific schedule number. At present, ten schedule numbers, are in use. They are 10, 20, 30, 40, 60, 80, 100, 120, 140, and 160.[3]

The nomograph presented here permits direct calculation of the schedule number when the internal working pressure P_W, and the allowable working stress, S_s, are known. The nomograph is based on equation (1) and covers the usual ranges of S_s and P_W.

To calculate the schedule number, simply connect the value of P_W with that of S_s in the vertical scales and read the value of the schedule number in the inclined axis.

If the schedule number is known for a given working pressure, the allowable working pressure can also be approximated from the nomograph.

Example. Find the required schedule for ordinary steel pipe having an allowable fiber stress of 10,000 psi for use at a maximum working pressure of 350 psig. Using the nomograph, the answer is about 35 which would be the proper schedule for welded joints and steel fittings, but not threaded connections. In practice, schedule 40 would be used for welded construction and schedule 80 for iron fittings. The higher schedule is used because of the weakness of the threads or iron fittings.

This item was submitted by J. F. Kuong, Atlas Powder Co., Wilmington, Del.

LITERATURE CITED

[1] American Standards Association, (A.S.A. B36.10)

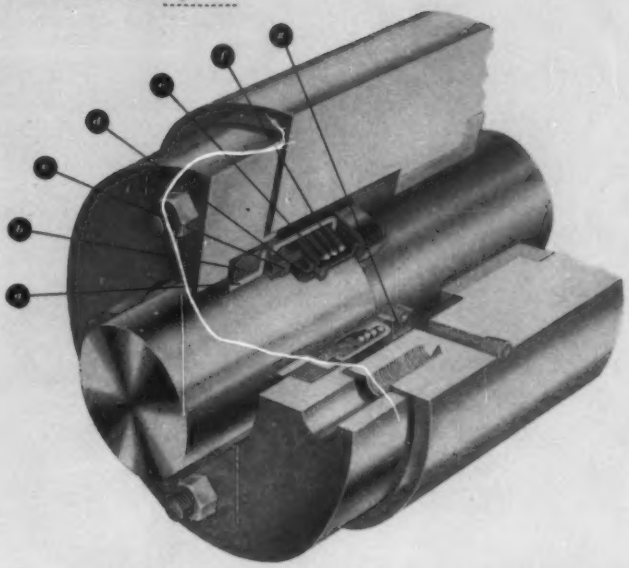
[2] Hesse, H. C., and Rushton, J. H., "Process Equipment Design." D. Van Nostrand Company, Princeton, N. J. 1945.

[3] Perry, J. H., "Chemical Engineer's Handbook." 3rd. Edition p. 1650. McGraw Hill Book Co., New York, 1950.

YOUR IDEAS ARE VALUABLE!

At least $10 will be paid for each idea accepted for "How to Do It." Just send a brief note with a photo or sketch to the Editor, *Petroleum Refiner*, P. O. Box 2608, Houston.

ONE OF THE GARLOCK **2,000**



GARLOCK Mechanical Seals —self-contained for easy installation, less downtime

a. ***Stationary Seat*** *of ceramic, Ni Resist, or bronze has precision lapped sealing face for perfect contact with carbon ring.*

b. ***Vibration Ring*** *of Buna-N positions stationary seat in a flexible mounting and acts as static seal.*

c. ***Seal Ring*** *of carbon is also precisely lapped to match sealing face of stationary seat.*

d. ***Roll type Bellows*** *permits free movement of seal ring.*

e. ***Shell,*** *encases entire rotary unit and furnishes mechanical drive for seal ring.*

f. ***Stainless Steel Spring*** *with load precisely calculated to face area of seal.*

g. ***Stop Collar,*** *or shoulder, positions seal to specified operating length.*

Garlock's PK MECHANIPAK* is designed to avoid excessive downtime. Self-contained, it can be installed simply and quickly, and eliminates adjustment during operation. Seal life is equal to many sets of conventional packings. Check these additional advantages:

Leak-proof sealing. Sealing faces of rotating and stationary parts are precision lapped for perfect contact, thus preventing leakage.

Elimination of shaft wear. No parts of the seal move on the shaft or sleeve, thus removing the danger of scoring or wear.

Maximum operating conditions are 212° F temperature, 150 psi pressure, 2000 fpm shaft speed. Available in shaft sizes from ⅜" to 3", PK MECHANIPAK Seals are another of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Find out more by talking with your local Garlock representative, or write for Catalog AD-150.

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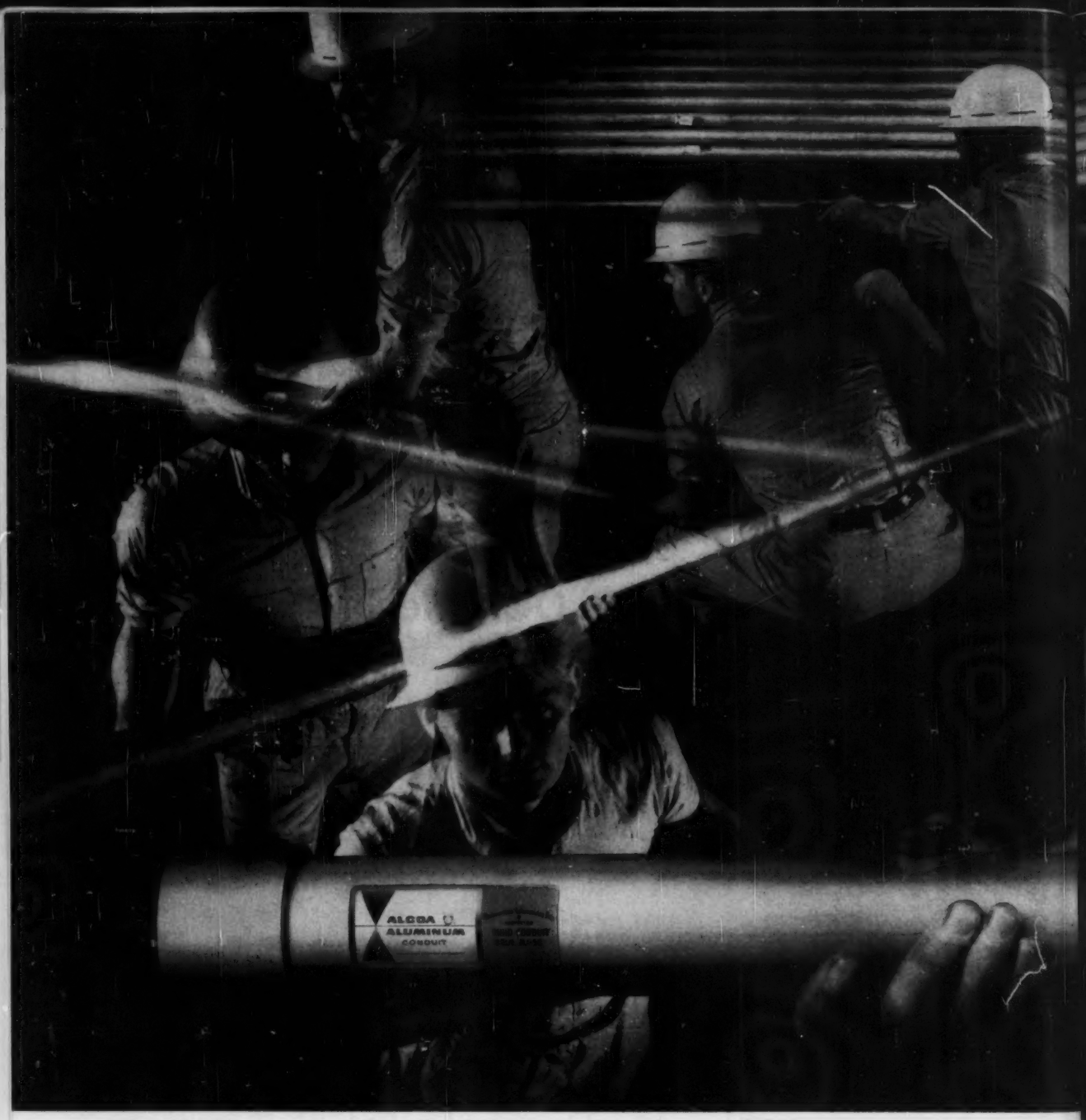

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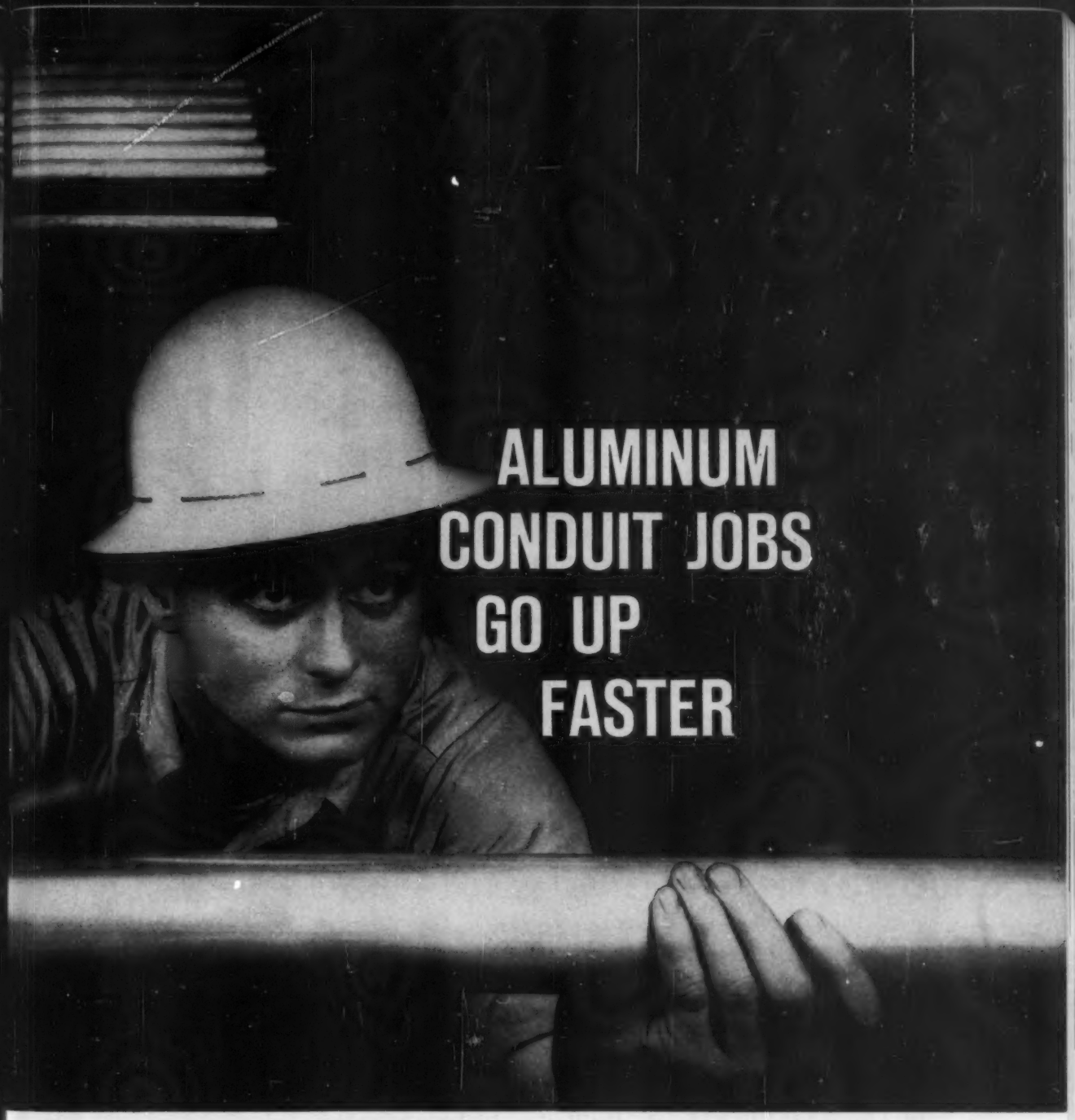

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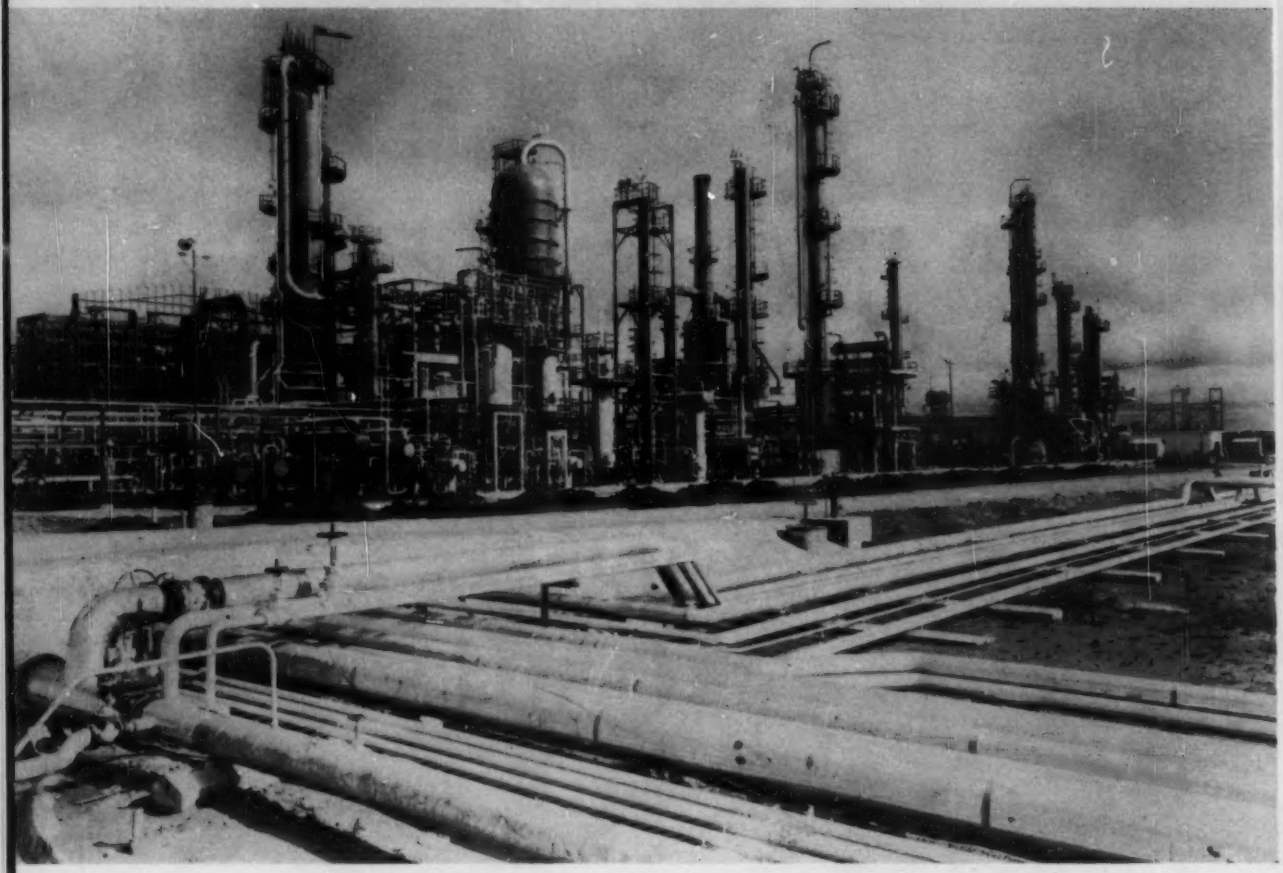
Who's Building...



Recently completed plant at Bordeaux, France, will process 31,500 bpd of French crude oil.

New French Refinery for Esso Standard

Plant uses two-stage crude distillation, hydrogen treating, reforming and light ends recovery

When The Lummus Co. completed construction this spring of Esso Standard Oil Co.'s new Bordeaux refinery, it added 31,500 bpd to France's refining capacity. The new Bordeaux installation is also the first refinery designed and built to operate on French crude. Crude flows through a 12-inch pipeline from Esso-REP's Parentis field south of Bordeaux.

The refinery's design permits production of LPG, motor gasolines, jet fuels, kerosine, diesel fuels, heating oils, light and heavy fuel oil, and asphalts. Automatic blending equipment has been included to produce the various grades of asphalt required for the French market.

The Bordeaux refinery uses atmospheric and vacuum crude distillation, with hydrogen treating and reforming to produce the required gasolines. Light ends and treating sections are also included for both the pipe still and Powerformer.

In addition to product shipping facilities, Lummus also provided complete auxiliary and off-site facilities, including storage tanks, steam generation, cooling water, electric power, and air—plus the necessary piping, transfer pumping and TEL blending.

In recent years *existing* refineries in France have expanded greatly. The new Bordeaux refinery, on the other hand, is a "grass roots" refinery—the

THE PROPER WIND IN SPIRAL-WOUND

It's the precise control of gasket densities for every stage in the pressure series that makes each Flexitallic Gasket right for a given flange.

Flexitallic Spiral-Wound Gaskets are engineered to meet extreme conditions encountered in keeping with the pressure/temperature rating for the specified assembly.

These controls mean that a Flexitallic Gasket, designed for an extreme pressure/temperature rating, is never so soft that it crushes under the specified load, and never so hard that it resists the compression necessary for a specified seal.

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second built in France since World War II. Lummus has handled the engineering and construction of both.

Although the refinery will operate at 31,500 bpd initially, facilities are designed to permit expansion to a 45,800 bpd throughput at minimum cost.

The Bordeaux project was handled by Lummus' French company, Societé Francaise des Techniques Lummus, with specialists from Lummus in the United States teaming up with those from Paris.

This unit is part of multi-million-dollar modernization program.

New Propylene Tetramer Unit for Lion

The first shipment of propylene tetramer was made recently by Lion Oil Division of Monsanto Chemical Co. from newly completed manufacturing facilities at the company's El Dorado refinery. This marks one of the first steps by Lion to supply other divisions of Monsanto with petrochemical raw materials from the refinery.

Shipped in 10,000-gallon tank cars, the new product is going to a Monsanto Inorganic Division plant at Monsanto, Ill., where it will be utilized as an intermediate in the manufacture of synthetic detergents.

Construction of the new propylene tetramer unit was started in May and completed in October. The unit, built by Procon, Inc., is part of a multi-million dollar modernization program started at the refinery late in 1957. It includes construction of a 5,000-bpd catalytic reformer for higher octane gasolines, a 5,000-bpd hydrodesulfurization unit for high quality diesel fuels and burner oils, and a 5,000-bpd solvent deasphalting unit for increased yields of paving grade asphalt and gasoline.

Phillips Petroleum Co. is starting construction of a natural gasoline plant near Artesia, N.M., to be known as the Artesia plant. Completion is scheduled for the fall of 1960.

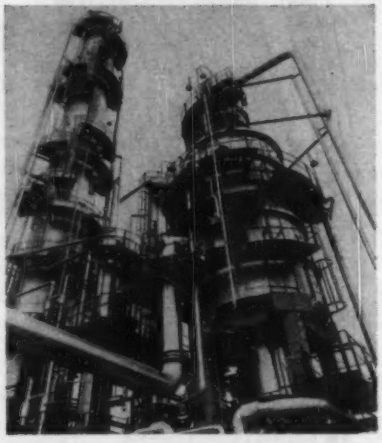
This plant will process natural gas from the Atoka, Dayton Abo, Empire Abo, East Millman, Artesia, Red Lake and other fields. Initial daily gas processing capacity will be 35 MMcf with a compressor capacity of 25 MMcf. Natural gas liquids recovery capacity will be approximately 100,000 gallons per day. The plant will be so designed that capacity can be enlarged to take care of additional gas as further development occurs in the area.

The liquids will be transported by pipeline to Phillips processing centers near Borger in the Texas Panhandle and at Sweeny, South of Houston.

The Ohio Oil Co. will build a natural gas processing plant to serve the rapidly developing Scipio, Pulaski and Albion fields of South Central Michigan. To be located three miles south of Pulaski in Hillsdale County, it will have a capacity of 25 MMcf of natural gas daily, and is to be completed by mid-1960.

The plant will cool the wet casinghead gas by refrigeration to drop out certain liquefiable gases while other units will absorb remaining liquefiables. The liquids to be extracted are a butane and natural gasoline mixture. Pipe is already arriving and the company will soon lay gathering lines which will bring in unprocessed gas from wells in the area.

The butane and natural gasoline mixture will be blended into motor fuels and the processed dry gas will go to transmission and distributing companies for home heating and industrial fuel.



E. I. du Pont de Nemours & Co. is building a new plant to produce methylamines at its Belle, W. Va., site. Construction, to begin next year, is slated for completion by early 1961. The company will use its own process of direct synthesis from methanol and ammonia. Methylamine derivatives, dimethylacetamide and dimethylformamide, will also be produced.

Bunawerke Huels synthetic rubber plant at Marl, West Germany, has attained full capacity of 45,000 tons per year. The company plans a further expansion to 70,000 tons per year by summer 1960.

Shell Chemical Corp. has put a phenol unit on stream at its Houston plant. Unit output is being used by Shell Chemical and Shell Oil Co. as a raw material for chemical manufacture and for process uses. The largest requirement is in the manufacture of bisphenol-A, a principal ingredient of Shell Chemical's resins. Construction of the unit began early this year.

India has accepted the U.S.S.R.'s terms for aid in building a proposed 40,000-bpd plant at Barauni. The agreement provides for a long-term Soviet loan which India had previously felt was inadequate for a "first-class" refinery.

More Capacity for Canada At Sarnia, Ontario, Plant

Canadian Oil Companies, Ltd., has completed an $8-million expansion of its Sarnia, Ont., refinery, upping the refinery's capacity from 30,000 to 50,000 bpd. The expansion program included construction of a 20,000-bpd crude unit, a Unifiner, and the enlargement of several existing units.

The Unifiner will allow the refinery

LUMMUS ENGINEERS, CONSTRUCTS NEW 31,500 BARREL PER DAY REFINERY FOR ESSO STANDARD S.A.F. AT BORDEAUX

When Lummus completed construction this spring of Esso Standard's new Bordeaux refinery, it added 31,500 barrels per calendar day to France's refining capacity. The new Bordeaux installation is also the first refinery designed and built to operate on French crude. Crude flows through a 12" pipeline from Esso-REP's Parentis field south of Bordeaux.

In recent years *existing* refineries in France have expanded greatly. The new Bordeaux refinery, on the other hand, is a "grass roots" refinery – the second built in France since World War II–and Lummus has handled the engineering and construction of both.

Although the refinery will operate at 31,500 barrels per day initially, facilities are designed to permit expansion to a 45,800 B/D throughput at minimum cost.

The refinery's design permits production of LPG, motor gasolines, jet fuels, kerosene, diesel fuels, heating oils, light and heavy fuel oil, and asphalts. Automatic blending equipment has been included to produce the various grades of asphalt required for the French market.

The Bordeaux refinery uses Esso Research and Engineering's "Hydro-Skimming" processing plan, which consists of atmospheric and vacuum distillation, with Hydrofining and Powerforming to produce the required gasolines. Light ends and treating sections are also included for both the pipestill and Powerformer.

In addition to product shipping facilities, Lummus also provided complete auxiliary and off-site facilities, including storage tanks, steam generation, cooling water, electric power, and air – plus the necessary piping, transfer pumping and TEL blending.

The Bordeaux project was handled by Lummus' French company, Societé Française des Techniques Lummus, with specialists from Lummus in the United States teaming up with those from Paris.

For design, engineering and construction of refineries anywhere in the world, contact one of the eight Lummus offices – and draw on more than 50 years' experience on over 800 major installations.

On the unusual heater exhaust system shown above, all vertical heaters exhaust into diagonal flues which feed one central stack.

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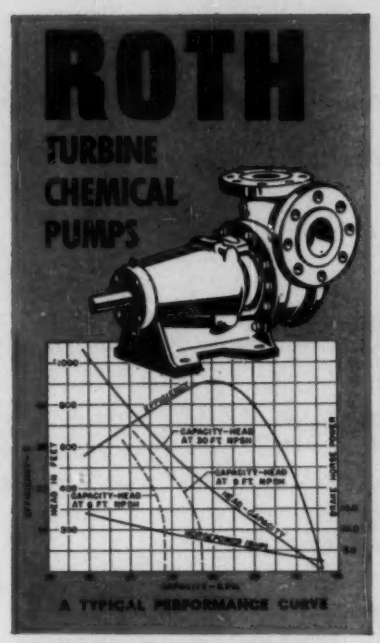

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greater flexibility in the types of crude oil it can process into a full range of quality products. This includes a certain type of Saskatchewan crude for which there had been no ready market. One of the first of its kind in Canada, the Unifiner, with its related facilities, cost $1.5 million. Work on the overall expansion program was carefully dovetailed by Canadian Oil's engineers so that it did not interfere with the normal running of the refinery.

In addition to the new crude unit and the Unifiner, the motor fuel Platformer was redesigned and enlarged to double capacity. A new electric sub-station was also included in the program. The catalytic cracking unit was also expanded and a new steam generating plant and a crude oil metering station were built.

The plant uses Western Canadian crude exclusively.

Texas cycling unit will increase capacity to 150 MMcf of gas per day.

Expansion for Shell's Plant at Sheridan

An expansion program costing about $1 million will get under way at Shell Oil Co.'s Sheridan, Texas, cycling plant during the first quarter of 1960. Throughput of the Colorado County plant will be increased to about 130 MMcf of gas per day from its present 110 million. Ultimately, total plant capacity will be 150 MMcf. New facilities will also permit recovery of approximately 2,000 bpd of additional liquid products. Scheduled for completion by the end of 1960, the project calls for construction of additional field gathering lines, absorption facilities and new refrigeration equipment.

The Dow Chemical Co. will form a wholly-owned subsidiary to manufacture polystyrene plastic in Greece. The Greek government has approved Dow's investment in a plant to cost more than $1 million. It will be built as soon as a definite site has been selected, and will begin operations in early 1961.

The facility, utilizing imported raw materials, will be the first to produce polystyrene in Greece. Output is scheduled for both the Greek market and for export.

The company will be held financially by Dow Chemie A. G., Basel, Switzerland.

Reserve Oil and Gas Co. has completed a new natural gasoline plant, the "largest of its particular type in existence," in the North Tejon Field, Kern County, Calif. The new plant, operated by Reserve under joint ownership of Reserve and Standard Oil Co. of Calif., Western Operations, Inc., is a dry dessicant, adsorption unit designed and built by Parkersburg Rig and Reel Co. The unit, completed November 1, has the capacity to strip natural gasoline from 35 MMcf of gas per day. This capacity is sufficient to treat present production in the area and allow for a substantial increase for additional wells.

The new plant, which can be expanded

Oakite ECP
engineered cleaning program

soak tank method cuts bundle cleaning costs 70%

Clogged almost solid with caked-on carbon, heat exchanger tube bundles took their toll on muscles and cleaning budget at one refinery. Hand sawing just one 60-tube, 12-foot bundle cost $392 in labor alone.

Refinery engineers called in the Oakite man. The ECP for this refinery included a recommendation to soak exchanger bundles in a hot solution of Oakite Compound No. 85. Now, there's no back-breaking manual labor needed. Bundles come out of the tank far cleaner than when handled manually, and the cost *per bundle* is only $120 including labor and Oakite material.

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DE LAVAL

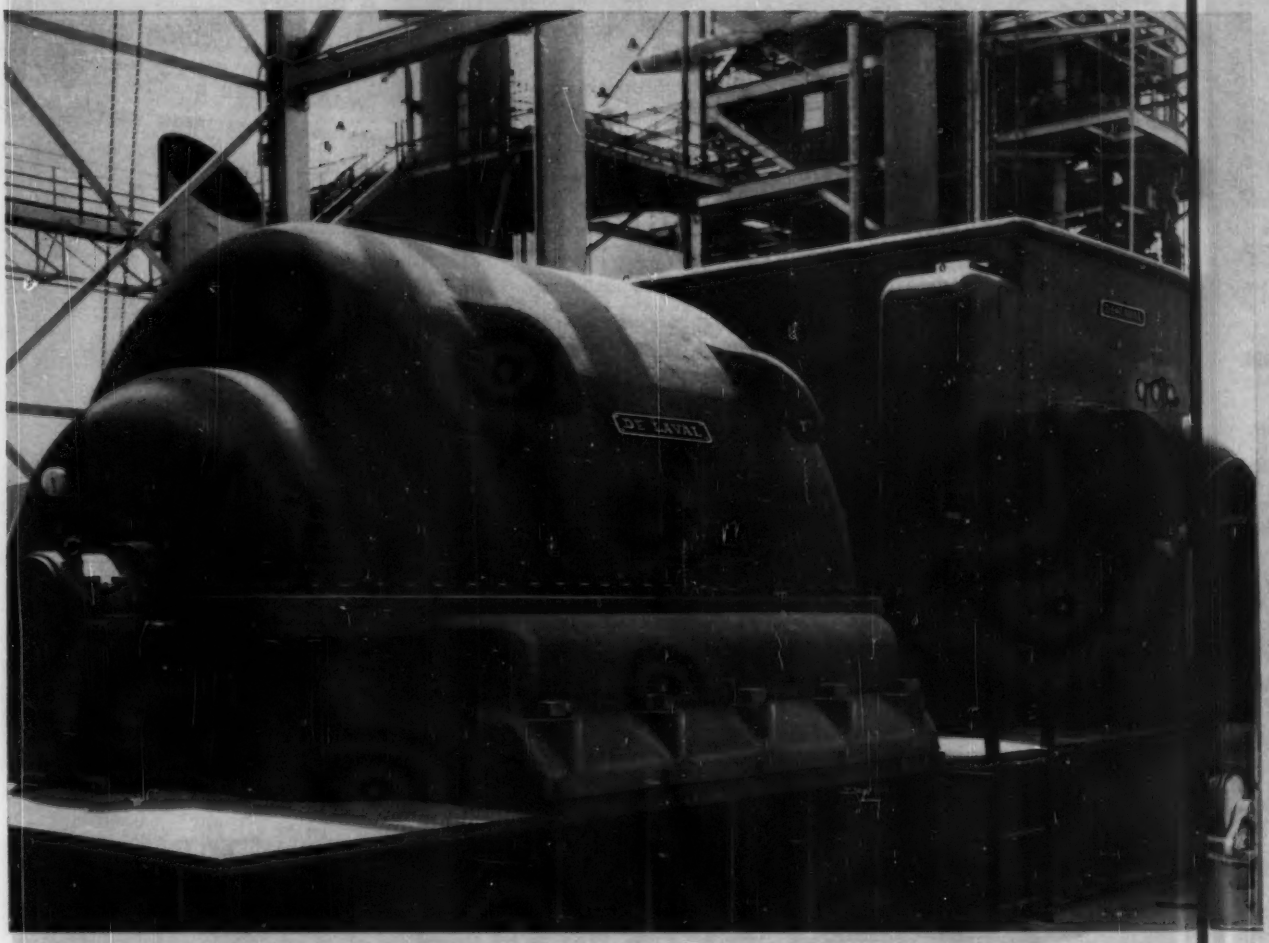
CENTRIFUGAL COMPRESSORS

Driven by automatic extraction steam turbine

Shown below is the large 11,300 horsepower centrifugal blower which compresses air for the main blower service in catalyst regeneration at Standard Oil of Ohio's new refinery at Toledo, Ohio.

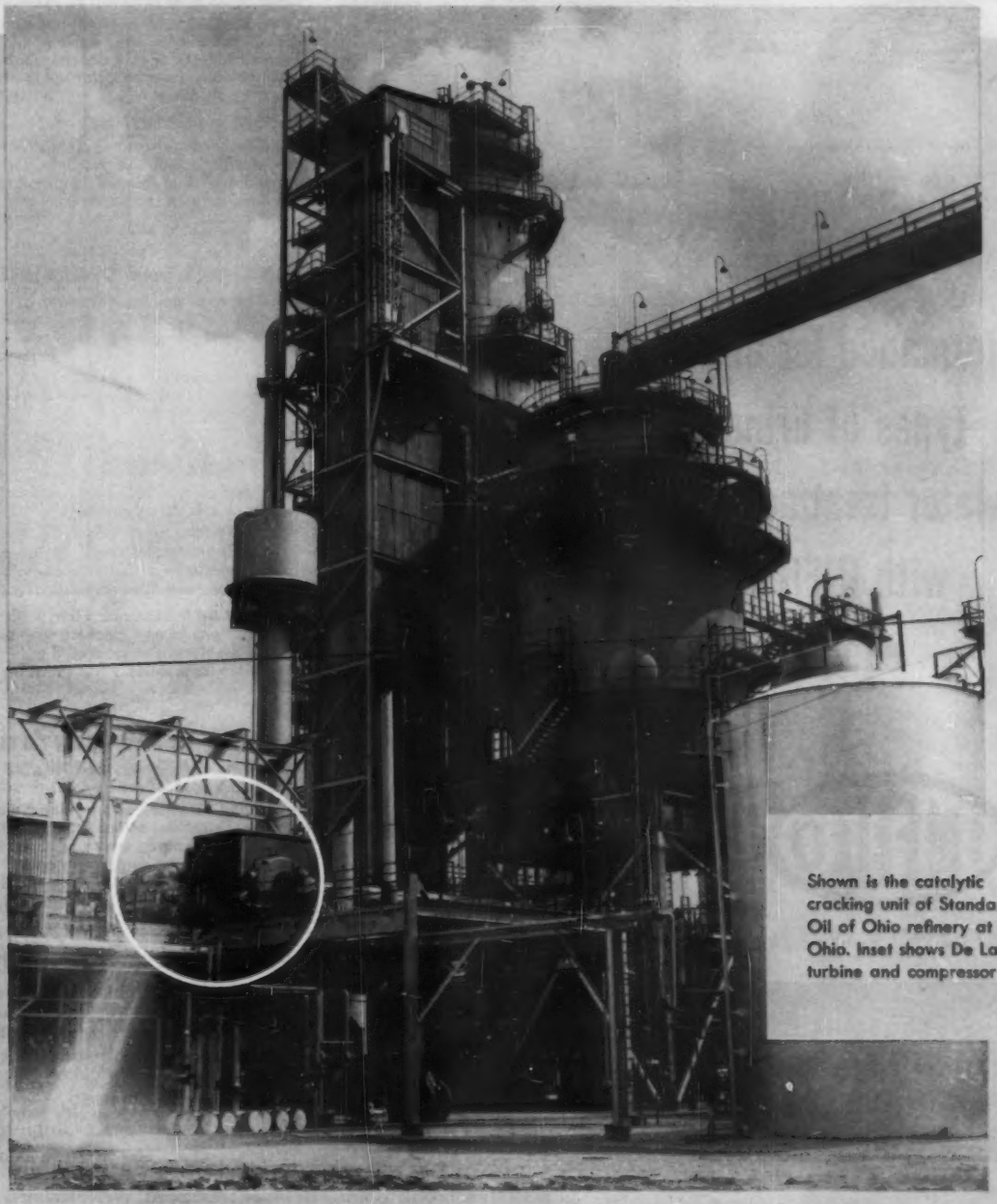
Driven by a De Laval single automatic extraction steam turbine, it compresses 110,300 cfm in four stages at 2800 rpm. Inlet pressure is 14.7 psia and discharge pressure is 40.7 psia. The turbine is designed for 600 psig ISP, 740F extracting at 55 psig, and exhausting to 28" Hg.

This is another example of De Laval proved performance.



DL-437

00 horsepower DE LAVAL compressor for "cat cracker" at SOHIO refinery



Shown is the catalytic cracking unit of Standard Oil of Ohio refinery at Toledo, Ohio. Inset shows De Laval turbine and compressor unit.

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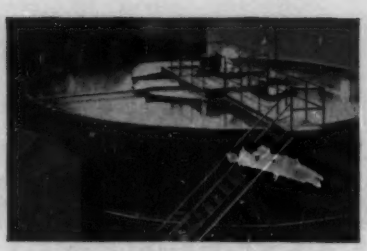

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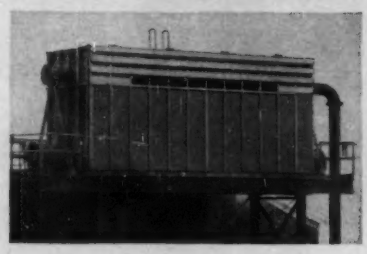

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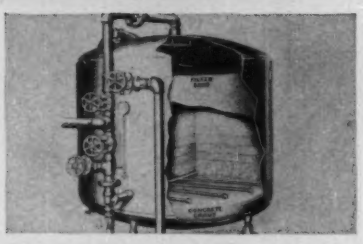

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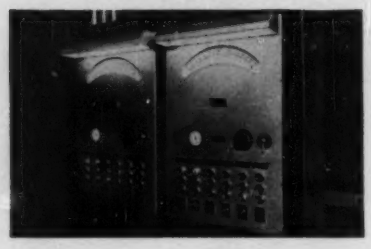

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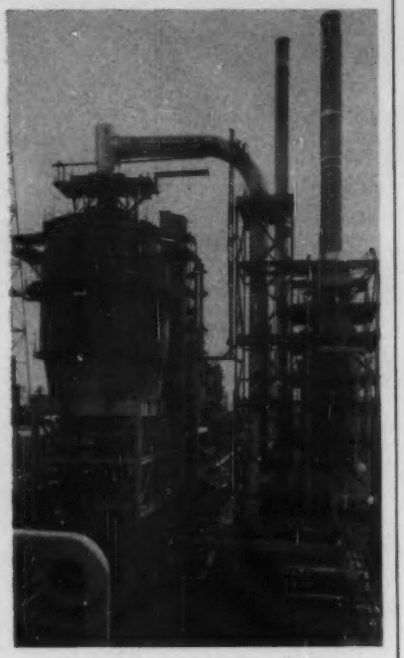
when and if size of the field warrants, at present is treating only high pressure gas from the field. Compressors will be added later to compress low pressure gas for treatment through the unit. When this is done, output of the plant from the existing gas production will be about 6,000 gallons of gasoline per day.



Gulf Oil Completes New Carbon Monoxide Boiler

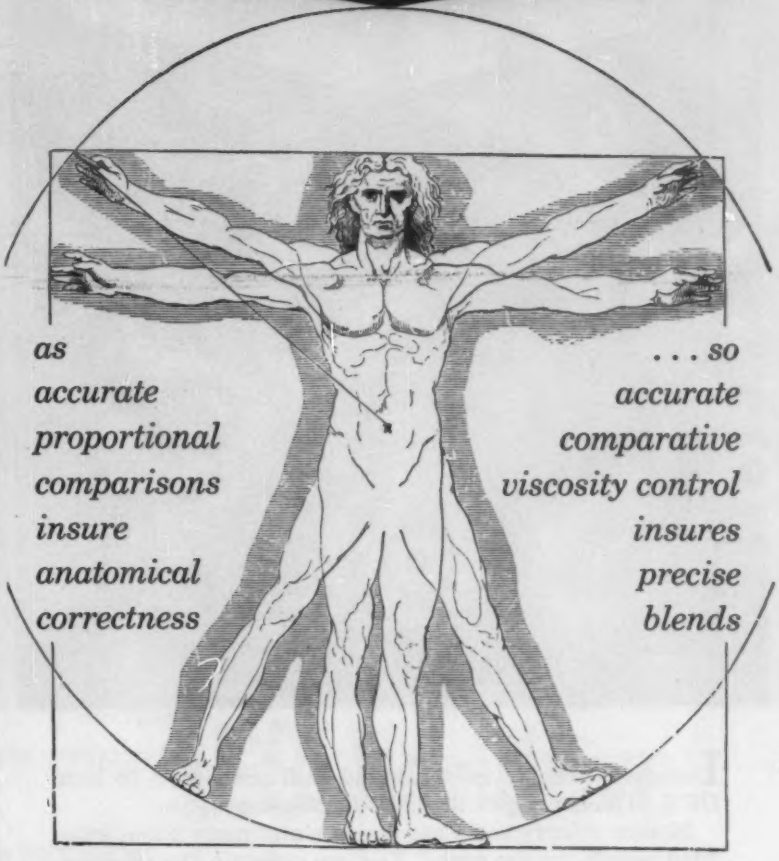
Gulf Oil Corp. has completed a new carbon monoxide boiler at its Port Arthur Refinery. Shown in the picture is one of the world's largest fluid catalytic cracking units. To the right is the new boiler, also one of the largest in the industry. During the processing of more than 2 million gallons of gasoline a day, large volumes of carbon monoxide went out the stack. This vapor is now routed to the new boiler where its intense heat is converted to steam. The steam is then piped to other units in the refinery.

The daily steam produced by this boiler, if converted to electricity, would provide a day's electrical service for approximately 75,000 homes or a residential population of 300,000 persons.

Ashland Oil & Refining Co. plans to construct the first commercial hydrodealkylation plant to produce synthetic benzene and naphthalene from petroleum. The new unit, which will be constructed at Ashland Oil's Buffalo, N.Y., refinery, will produce a maximum of either 12 million gallons per year of benzene or 50 million pounds of napthalene, or a combination of the two products.

A significant feature of the hydrode-

WHAT HAS THIS TO DO WITH VISCOSITY?



as accurate proportional comparisons insure anatomical correctness

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Building . . .

alkylation process is the purity of the benzene and napthalene products. Typical pilot plant operations produce benzene having a freezing point of 5.5° C and refined grade napthalene having a melting point of 80.0° C. The benzene and napthalene will be used in the manufacture of plastics, insecticides and various chemical intermediates. The new facility will also be designed to desulfurize, dealkylate and purify coal tar light oils to benzene, toluene and xylene.

The process, which has been under development in Ashland Oil's laboratories for several years, will be licensed by Universal Oil Products Co. to the petroleum and chemical industries (see PETROLEUM REFINER, Nov., 1959, page 258).

The Goliad Corp., in conjunction with Union Oil Co. of Calif., has awarded a $4-million contract to The Fluor Corp., Ltd., to perform engineering, purchasing and construction of a 450-MMcf-per-day natural gasoline plant in Vermillion Parish, La.

The plant will be composed of absorption, distillation, glycol and sponge oil units, and it will include refrigeration, power and steam generation facilities. Engineering and purchasing for the job has begun, and construction of the facility is to begin soon.

Ente Nazionale Idrocarburi plans to finish construction of its $15-million, 25,000-bpd Moroccan-Italian refinery by the end of 1962 at Mohammedia, Morocco. The construction site, 19 miles from Casablanca on the Atlantic Ocean, can handle 12,000-ton tankers and 40,000-ton ships with offshore loading lines. Samir Refining Co. will operate the plant with 50 percent Moroccan and 50 percent ENI capital, and within eight years 80 percent of Samir's personnel must be Moroccans.

The Dow Chemical Co. plans to build a new plant to manufacture styrene-butadiene latexes at Allyn's Point, Conn. The company also will expand styrene-butadiene latex capacity of its Texas Division at Freeport. Engineering for both expansions is underway.

The Connecticut plant will become a part of Dow's Allyn Point Division which manufactures two other major Dow plastics. Production of latex there is scheduled for early 1961.

Phillips Petroleum Co. will construct a new heavy oil catalytic cracking unit at its Borger, Texas, refinery. To materially increase the refinery's production of high-octane motor fuel, it will have a capacity of 25,000 bpd.

In addition to bringing catalytic cracking capacity of the refinery to a total of 65,000 bpd, the unit will permit selective cracking of different feedstocks. Construction of the unit, by The M. W. Kellogg Co., will begin in early 1960 and be completed early in 1961. The unit is

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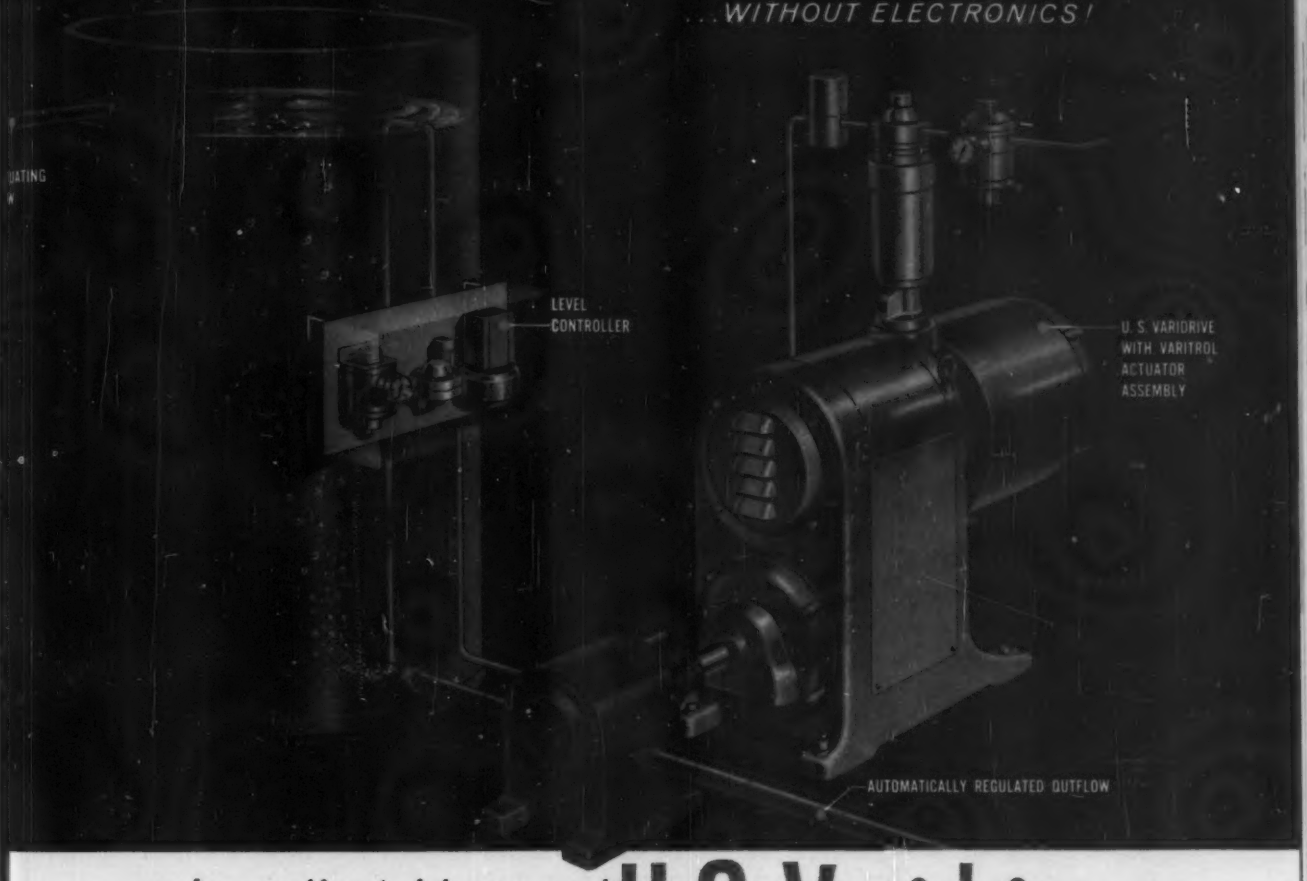

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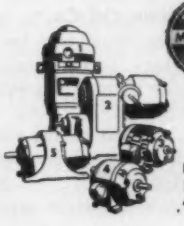

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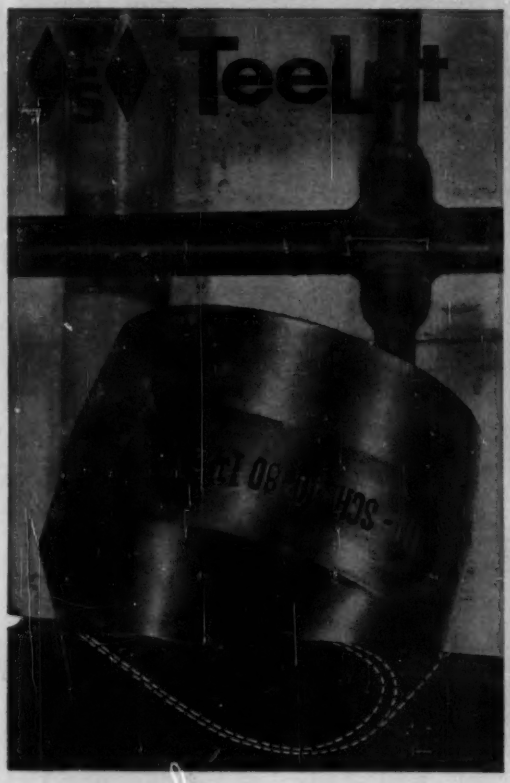

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What about cost? A size-by-size comparison with conventional Tees shows TeeLets average less than 50 per cent of the cost you now pay. A W-S TeeLet, with screwed, socket-weld or butt-weld ends, requires no shaping, fitting, beveling or extra alignment. You can connect to the run-pipe at any point. Short heights mean easy inspection of the attachment weld or back-weld, if desired.

A W-S TeeLet costs less to buy, less to install than anything you can buy or make. For complete information, prices, and names of distributors, write: *Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.*

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Building . . .

being designed by Phillips and Kellogg engineers.

Phillips also will enlarge and improve present refinery equipment for recovering and separating light hydrocarbons from both crude distillation and cracking operations. Additional storage and production handling facilities will be installed.

Humble Oil & Refining Co.'s King Ranch gas plant, 14 miles from Kingsville, Texas, is well underway with construction. Concrete foundations for the various units have been poured and major equipment is arriving rapidly. The 800-MMcf-per-day plant, which will recover 28,000 bpd of liquid products, is to be completed in mid-1960. Already complete are initial recycling operations, from which liquids are being recovered by normal separation. Separator gas is then compressed by seven 2,000-hp compressors for injection into producing reservoirs.

Badische Anilin & Soda Fabrik has completed an olefin plant at its Ludwigshafen, West Germany, facilities. It differs from other European olefin plants, in that it uses crude oil rather than light naphtha or other petroleum fractions as raw material. The crude is cracked in a fluidized bed of petroleum coke (turbulent layer process). Crude oil is fed into the hot fluidized bed of coke particles, which are actually formed during the process. Conditions can be controlled so the particles are not formed in excess.

Stauffer Chemical Co. plans to construct a new carbon bisulphide plant at Delaware City, Del. The unit, to be located on property purchased from Tidewater Oil Co., will undergo construction shortly and be completed in November 1960.

The plant will use methane from Eastern Shore Natural Gas Co. and sulfur from Tidewater. Designed and engineered by Stauffer's Engineering Department, the new petrochemical unit will use processes currently employed at Stauffer's bisulphide plant, LeMoyne, Ala.

Cie Francaise des Petroles and six other participating companies have set 1962 for completion of a 44,000-bpd refinery at Algiers, Algeria. To process Sahara crude oil (but capable of processing sour crudes) the plant's other owners will be Esso Standard Oil Co., Shell Oil Co., Mobil Oil Co., British Petroleum Co., Cie Francaise de Raffinage, and Beryl Algeria, which will own a combined interest of 76.2 percent.

British American Oil Co. is building Ontario's first ankylation unit for use in manufacturing high octane gasolines at its Clarkson refinery, near Toronto. The $3-million plant will be B-A's second alkylation unit, the first having gone into operation at the new refinery built last year at Port Moody, B.C.

The Clarkson unit will be capable of

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This could be *your* sample ethanolamine solution that is being injected into a gas chromatograph for chemical analysis. This is just one of the many methods used by Jefferson's extensive research laboratories in Austin, Texas, to help you solve your gas processing problems. A wealth of technology and experience in such problems as high temperature corrosion, contamination, foaming characteristics, and excessive glycol losses is available expressly to serve your needs.

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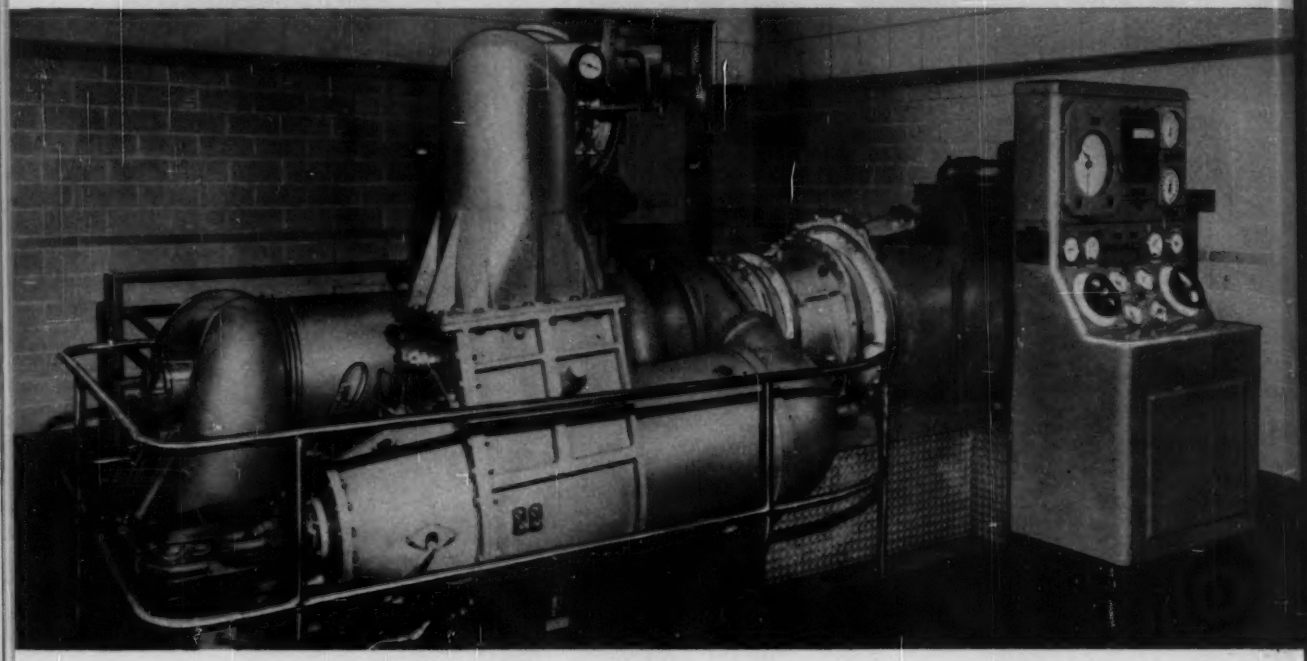

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A products pipeline, two widely differing mining operations, a catalytic cracker, a gas/gasoline plant join the trend to gas turbines for power in field and plant applications. And they choose the Clark Mark TA Gas Turbine because this lightweight packaged unit is demonstrating dual advantages and economies. Power generation is a prime function, but as an operating bonus, its hot exhaust gases can generate process steam, hot water and air.

There are sound reasons for the growing popularity of Clark Gas Turbines. An efficient, single combustion chamber—using gaseous or liquid fuel—provides the design simplicity and dependability required for long service life with minimum maintenance. Thermo-elastic design makes it possible to accept full load quickly without stress. Dual-shaft construction assures maximum speed flexibility for process use. Air cooling makes Clark Gas Turbines ideal for locations where short water supply is a problem.

The Clark Mark TA Gas Turbine is conservatively rated at 1220 bhp, with a normal output speed of 6000 rpm. Three other standard speed models are available. For applications requiring more horsepower, Clark 302 and 305 Gas Turbines are rated up to 9300 bhp.

Your nearest Clark representative has full information on all Clark Gas Turbine models. Or simply write for Bulletins 162 and 163-1 to Clark Bros. Co., 1330 Lincoln Ave., Olean, N. Y.

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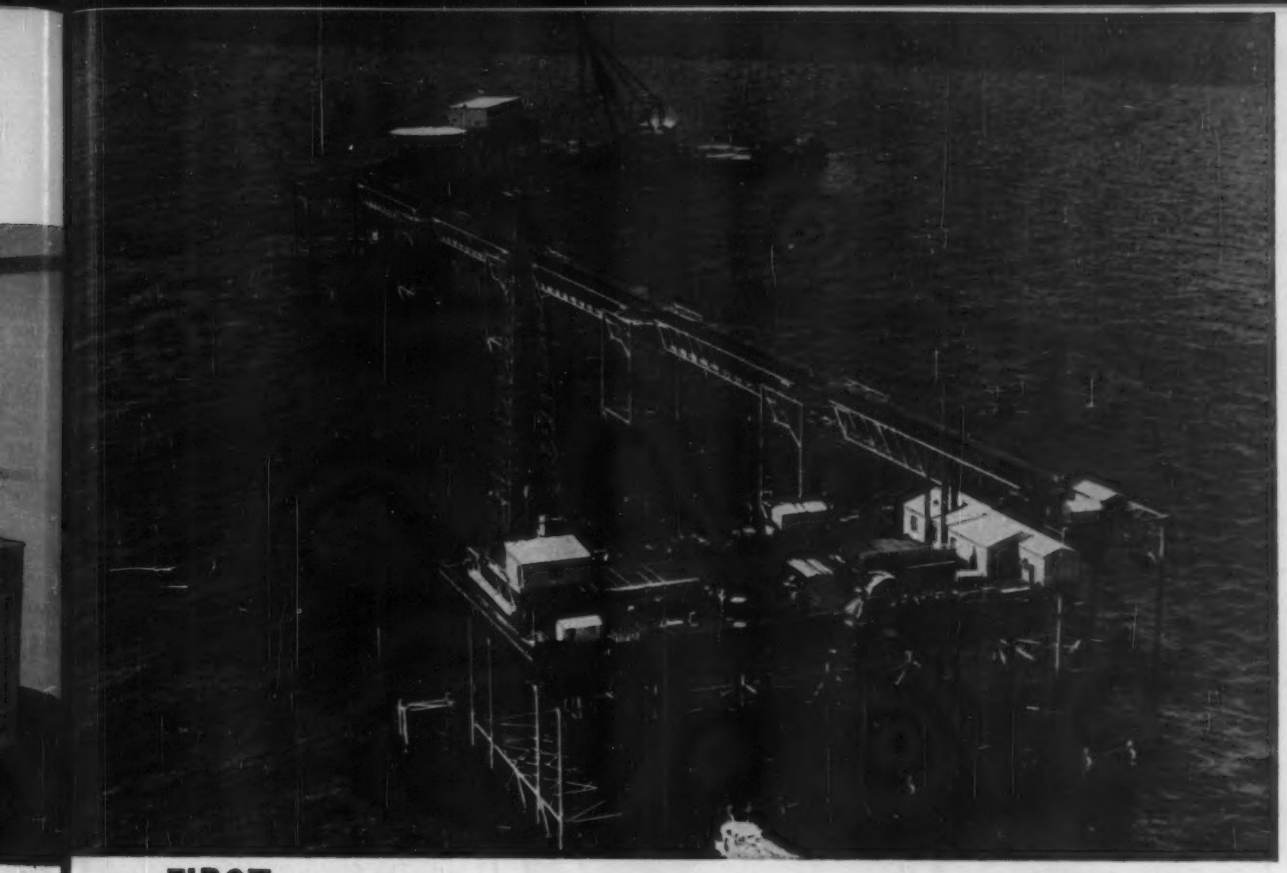
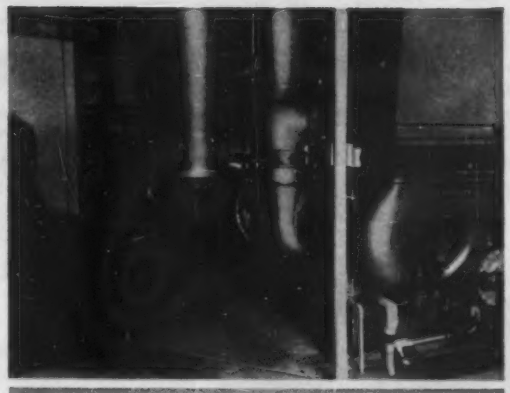


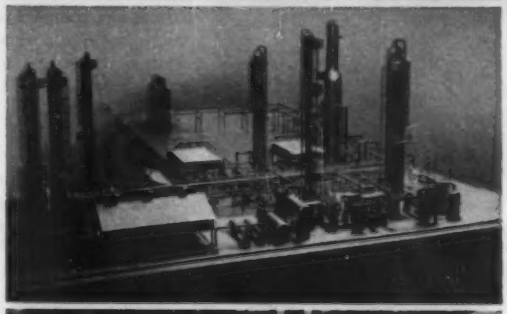
FIRST IN OFFSHORE SULPHUR MINING

Seven miles out in the Gulf of Mexico, Freeport Sulphur Company uses a Clark Mark TA as prime mover in the production of molten sulphur from a deposit 2000 feet below the surface of the Gulf. The Mark TA by driving an electric generator produced power for the drilling rig that put down the production wells (this is the first time a gas turbine has been used on an electric rig). After the main power plant is on stream, the Mark TA will continue in service: (1) Producing part of the plant electrical power used for many vital functions including powering the Clark Balanced/Opposed Compressors supplying the air which lifts the molten sulphur to the surface, (2) Supplying the boilers with hot combustion air which, with supplementary fuel, will generate the steam necessary to heat 5 million gallons of water per day used to melt the sulphur deposit.



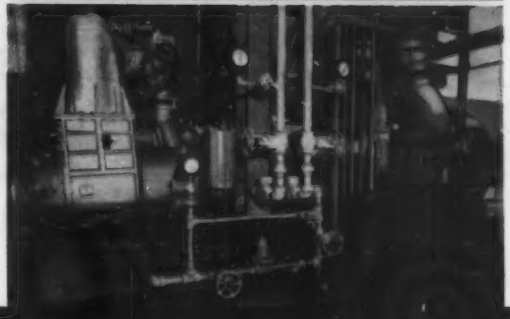
FIRST IN OPEN PIT MINING

This Clark Mark TA driving a generator not only supplies electricity for operation of the Greybull, Wyoming, installation of the Magnet Cove Barium Corporation, but in addition its exhaust gases are used for drying ore. Even discounting the ore-drying bonus, the mine manager reports "better than anticipated fuel economy."



FIRST IN GAS/GASOLINE PLANT

All electric power requirements plus generation of process steam in a waste heat boiler will be accomplished by a Clark Mark TA in the gas processing plant now being constructed for Sun Oil Company near Laverne, Oklahoma (model shown). Initial plant capacity is rated at 100 M.M.s.c.f.d. A projected 50 percent expansion can be accomplished with the same power unit.



FIRST ON A SMALL CAT CRACKER

This Clark Mark TA, mounted outdoors, drives a cat cracker blower supplying air directly to a catalyst regenerator at the Duncan, Oklahoma, refinery of DX Sunray Oil Company. Though larger gas turbines have been used in this manner before, the Mark TA is demonstrating the efficiency of smaller applications. The Mark TA Gas Turbine is available through a licensing agreement between Ruston-Hornsby Ltd., Lincoln, England, and Clark Bros. Co.

Building . . .

producing 3,000 bpd of motor alkylate. The project will include construction of a 154-foot iso-stripper which will separate high octane alkylate and unreacted butanes. Off-site construction will include piping and tankage and enlargement of the existing inline gasoline blender. Procon (Canada), Ltd., has been awarded construction contract for the plant, scheduled for completion in the spring of 1960.

Collier Carbon and Chemical Corp. plans to build carbon and petrochemical production facilities at a site near Rodeo, Calif.

C.S.R.C.-Dow Pty., Ltd. has begun construction of a styrene plant at Altona, Australia. George Wimpey and Coy Ltd., has been awarded a contract to build the facilities along with Bechtel Corp., San Francisco, and McDonald Constructions Pty. Ltd., Sydney. The plant is to be completed by July 1961.

Gulf Oil Corp. has awarded Badger Manufacturing Co. a contract for the engineering and construction of a multimillion dollar iso-octyl alcohol plant at its Philadelphia refinery. Heptene and nonene are used as raw materials for the production of octyl and decyl alcohols.

Texaco, Inc., will add a 4,500-bpd gas-oil hydrotreater to its Casper refinery. Contracts for engineering, procurement and construction of the new installation have been awarded to Badger Manufacturing Co. Actual starting date for construction has not been announced but completion is expected late in 1960.

Phillips Chemical Co. will construct a new 60-million-pound-per-year carbon black plant four miles Northeast of Orange, on the Texas Gulf Coast. Plant design has been completed, and purchase of materials and equipment is under way. Completion is scheduled for the third quarter of 1960.

Burmah Oil Co. and three other firms have completed negotiations with the Pakistan Government for construction of a 1.5-million-ton-per-year refinery in Karachi. Other participating companies are Shell Petroleum Co., California Texas Oil Co., and Standard Vacuum Oil Co.

Reichold Chemicals, Inc. has completed a new 15,000-ton-per-year phthalic anhydride plant at Elizabeth, N.J. The facility was designed by Badger Manufacturing Co.

Deutsche Erdoel, West Germany independent company, plans to boost capacity of its Heide refinery to 50,000 bpd by 1963 from the present 30,000 bpd. The firm will also expand polyethylene facilities.

Thailand is said to be planning a 5,000-bpd refinery of its own. The unit would be built by a Japanese firm and financed by French banks.

Valley Nitrogen Producer's Cooperative has completed construction of a 150-ton-per-day anhydrous ammonia plant at Helm, Calif. The company also plans to build ammonium sulfate, ammonium phosphate and phosphoric acid facilities.

Collier Carbon & Chemical Corp. will build facilities for sulfuric acid and ammonium sulfate production near Wilmington, Calif. The plant will go up on a former Union Oil Co. of Calif. site.

Canadian Husky Oil Co. has started up its new Fort William, Ont., refinery. The 4,200-bpd unit, which uses Venezuelan crude, formerly used crude shipped by rail from Eastern Saskatchewan.

Federated Cooperatives, Ltd. has completed a Platforming-Unifying unit at Regina, Sask. The $2-million facility will up the company's annual production of heating, diesel and furnace oils by 10 million gallons.

A/S Esso-Raffineriet, Norge, a subsidiary of Standard Oil Co. (New Jersey), is building a 40,000-bpd refinery on the shores of the Oslofjord in Norway. To be the nation's first major petroleum refinery, the plant will be built by Bechtel Corp. and Sverdrup & Parcel, Inc., St. Louis. Engineering is being done in

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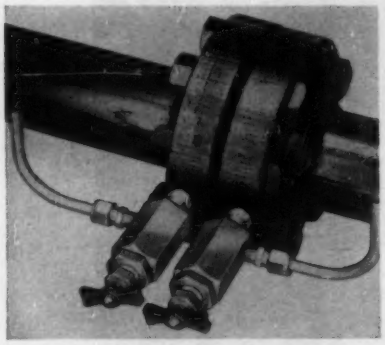

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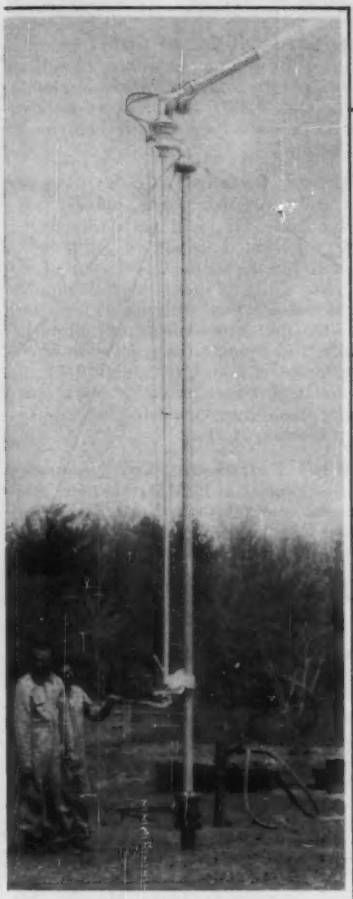
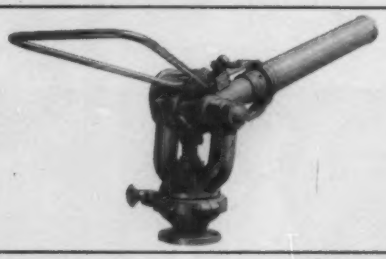
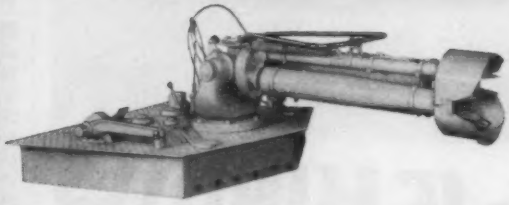


Extended Manual Control Type — Turret nozzles extend 10 to 20 feet above remote control station on deck or ground on standard units . . . greater remote extensions for special applications.

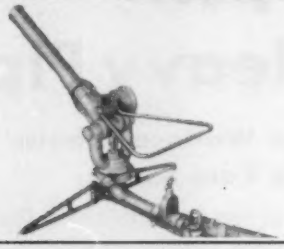


Direct Manual Control Type — Gives fire fighters "out-in-the-open" control from cab roof!

Remote Manual Control Type — Easily handled by man in driver's seat. Ideal for fast action!



Remote Hydraulic Control Type — Power-controlled from within the cab. Single and dual models. Widely used on air crash rescue fire-fighting trucks.



Portable Type — Off the truck and into action in seconds! Goes wherever a fire fighter can bring the proper hose line into action!

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Engineers Water ... to Cut Fire Losses
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For more data on advertised products, use Readers' Service Cards, last page.

Building . . .

Rome, Italy, by Compagnia Technica Industrie Petroli under Bechtel supervision.

The new plant is a hydroskimming type designed by Esso Research & Engineering Co., and includes a crude distillation unit, a 7,200-bpd Powerformer, a 4,200-bpd gas oil hydrofiner and two copper chloride treating units with a joint capacity of 10,250 bpd. The plant will process Middle East crude oil and will produce gasoline, jet fuel, tractor vaporizing oil, diesel and heating oils, and light and heavy fuel oils.

Main offsite facilities will include tankage for storing 2.5 million barrels, and a marine terminal with three berths.

Monsanto Canada, Ltd. plans to construct a 6-million-pound-per-year maleic anhydride plant at Ville La Salle, Montreal, Canada. To be designed and constructed by Scientific Design Co., the unit is slated for completion in the fourth quarter in 1960.

Canadian Chemical Co. is planning a $4-million expansion of its Edmonton, Alb., petrochemical plant. The project, to be completed early in 1961, will boost the company's petrochemical production 40 percent.

Goodyear Tire & Rubber Co. plans to up capacity of extruded polyvinyl chloride film by 50 percent at its Akron, Ohio, facilities.

Pittsburgh Coke & Chemical Co. plans to construct a 20-million-pound-per-year maleic anhydride plant at Neville Island, Pa., adjacent to the company's main plant. To be designed and built by Scientific Design Co., the unit is slated for completion early in 1961.

Standard Oil Co. of Calif. plans to begin construction soon on 20-million-pound-per-year maleic anhydride plant at Richmond, Calif. The unit, to be completed in mid-1960, will use benzene for a feedstock.

Frontier Refining Co.'s planned $10.5-million, 10,000-bpd refinery near Jacksonville, Fla., will not undergo construction until a supply of crude oil is assured for the critical first year of operation. The company says a date to begin construction will not be set until it solves the "economic supply problem" involved in keeping the refinery in operation. Frontier hopes to "obtain a change in the import regulations or work out a competitive arrangement for some domestic petroleum stocks."

Phillips Petroleum Co. has started construction of a 35-MMcf natural gasoline plant near Artesia, N.M. To be completed next fall, the plant will recover about 100,000 gallons per day of propane, butane and natural gasoline. The liquids will be piped to Phillips plants at Borger and Sweeny, Texas.

The Dow Chemical Co.'s Texas Division plans to expand anhydrous ammonia facilities at Freeport, Texas. The project is scheduled for completion early in 1960, and includes an addition to the main building and new process equipment. Dow produces ammonia by combining by-product hydrogen from the chlorine process with nitrogen from the air.

Monsanto Chemical Co. plans to build a 20-million-pound-per-year maleic anhydride plant at St. Louis, Mo., in addition to the existing 40-million-pound-per-year unit. The new plant, to be designed and constructed by Scientific Design Co., is to go on stream by mid-1960.

Amoco Fina S.A., newly formed Belgian firm owned jointly by Amoco Chemicals Corp. and Petrofina, plans to begin construction immediately of a petroleum product additives plant at the Port of Antwerp, Belgium. Production is scheduled for early 1961.

Amarillo Oil Co., a subsidiary of Pioneer Natural Gas Co., will operate a new gas liquids extraction plant to be built in Gray County, Texas. The unit will have a capacity of 45 MMcf per day and will extract 52,000 gallons of butane and propane daily. Scheduled for completion by April 1960, the plant will be constructed by Dresser Engineering Co.

Korea Petroleum Co. has been formed by Korean interests to build a 20,000-bpd refinery near Ulsan, Korea.

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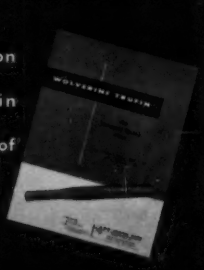

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New Books...

Management Methods

"Ends and Means of Modern Management" points out that achieving the basic corporate goals of survival and profitability is an increasingly complex undertaking for management today. Companies must help their executives understand the social, economic, political and other forces affecting these goals, and relate them to company operations.

This book shows how the company can deal with these broad but significant issues in terms of the manager's needs and requirements. Executives discuss how to promote a favorable political and economic climate for your company, how to improve productivity and morale, and how to use research results *strategically*. Other important areas of managerial planning and responsibility, including the management of foreign operations, are analyzed carefully.

In a special section, five leading companies describe cost/quality relationships in their organizations. Representatives of a steel company, a railroad, an electronic-components manufacturer, a chemicals company, and a supermarket chain, show how their companies maintain a high level of product quality in the face of rising production costs. This report is based on material originally presented at AMA's West Coast General Management Conference in California last January.

(AMA, *Ends and Means of Modern Management,* American Management Association, 1515 Broadway, New York 36, N.Y., 158 pages, $2.50 for AMA members, $3.75 for non-members).

Vapor Pressure Data

"The Vapor Pressures of Some Hydrocarbons in the Liquid and Solid State at Low Temperatures" (PB 151363) provides easy reference to vapor pressures of a number of hydrocarbons at low temperatures. Data in this NBS report were drawn from a literature survey for use in the analysis of low-temperature processes such as the purification of hydrogen, and the design of such apparatus as low-temperature distillation or scrubbing equipment and cryogenic baths.

The hydrocarbons are methane, ethane, propane, n-butane, isobutane (2-methyl propane), n-pentane, ethylene, propylene, 1-butene, acetylene, and cyclopropane. In general the range covered is from 1,500 mm down to approximately 0.001 mm Hg. For the most part, the data apply to the liquid range.

Some data for vapor pressures of solid methane, ethane, n-butane, ethylene, acetylene, and cyclopropane are included. The data were used to estimate triple-point pressures not previously available.

(OTS, *The Vapor Pressures of Some Hydrocarbons in the Liquid and Solid State at Low Temperatures (PB 151363),* Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C., 19 pages, 75 cents).

Facts and Figures on Oil

"Petroleum Facts and Figures," Centennial Edition, is a fact book prepared by the API's Committee on Public Affairs. The new edition provides a statistical history of the 100-year-old industry, including data on production, refining, transportation, marketing and utilization. It incorporates for the first time, historical highlights on each of the industry's major divisions, a glossary of important terms, and a bibliography.

(API, *Petroleum Facts and Figures,* American Petroleum Institute, 50 West 50th St., New York 20, N.Y., Free to API members, $4.50 for others.)

Flash Point Index

"Flash Point Index of Trade Name Liquids" (NFPA No. 325A) is a standard reference work for all who deal with flammable and combustible liquids. This new and revised edition, which has just been issued, lists more than 4,500 products, presenting data on the flash point of the liquid, the name of the manufacturer, principal use of the product, and the source of the information listed.

The new edition supersedes one published in 1957 under the title of "Trade Name Index of Flammable Liquids."

(NFPA, *Flash Point Index of Trade Name Liquids (NFPA No. 325A),* National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass., 160 pages, $1.50).

Tube Dimension Standards

Availability of two new tube dimension standards have been announced by the API.

- API Standard 630, Tube Dimensions for Fired Heaters. This standard establishes standard sizes and lengths of heater tubes recommended for all refinery services.
- Tentative API Standard 640, Tube Dimensions for Heat Exchangers. This standard contains recommended size, thickness, and length of ferrous and nonferrous tubes most commonly used in conventional shell and tube refinery heat exchangers.

(API, *Tube Dimensions for Fired Heaters (Standard 630), and Tube Dimensions for Heat Exchangers (Standard 640),* American Petroleum Institute, 50 West 50th St., New York 20, N.Y., 50 cents each).

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How to Get Along In Latin America

Good public relations is vital to both you and your organization. Here are a few tips which will enable you to interpret Latin America with a Latin American view

Thomas Garcia-Borras, Texas City, Texas

VICE-PRESIDENT Richard Nixon's tour in South America in 1958 may be considered a starting point in a new era of good neighbor relations between the United States and Latin America. U.S. investments south of the border are one-third of the total investments abroad; if further solid investments are to be made—and the challenge of European markets is to be met—good public relations or the "let's-be-friends" policy should be cultivated.

Suppose a Frenchman visiting this country asks you, "Is Mr. Hoover still your president?" You will probably think the visitor either had a few drinks or was pulling your leg. Yet that is the type of questions Americans often ask in Latin America. Of course, these questions certainly do not make friends, since they show a lack of interest in the country.

How then, should you conduct yourself in Latin America in order to get along with its people? Here are a few tips described with examples based on my experience in the Mexican chemical industry as well as in this country. They deal only with public relations, however, not how to conduct business.

A Sleeping Giant. Celanese, Du Pont and RCA are familiar companies with businesses south of the border that amount to one-third of the total U.S. investments abroad (*Fortune,* February 1958). Latin America is two and a half times larger than the United States, with almost 200 million people.

Latin America has long been a sleeping giant, but one which is quickly awakening. A typical example is the diversity of the chemical industry in Mexico. However, most of the other countries are "one-crop" countries and semi-colonial in structure. Each country has its own customs, its own national heroes, its own history; but, in one respect they are all alike: they are proud of their own country with a glorious past, a poor present and a promising future for most of them.

Know the language

This is the kind of nationalism not readily understood not accepted by foreigners. A criticism of their government or their social life will certainly hurt the people's feelings and your business too in the long run. What would be your reaction if a stranger would spank your spoiled child, then lecture you on how to bring up children? You would be disturbed. And Latin Americans do not want foreigners to lecture them either.

Be Informed. In addition to language and religion, Latin American inherited from Europe the "cult of culture." People are deeply concerned about culture for the sake of it. For example, Americans abroad are invited to discuss about radiation fallout or about the foreign policy of the United States in the Middle East. Latins do not mean to bother you. They just take for granted that everybody knows what is going on around.

If you do not know the right answers, let them tell you about their country. Latin people love to talk and you will probably learn something new from them.

Resentments in Latin America toward the United States might be summarized by the general feeling that "Latin America is an important friend in war, but forgotten in peace." This is not quite true; but so far, no one has convinced them why this country should be so generous in foreign aid toward European and other countries, including communist Yugoslavia, while the U.S. free enterprise sometimes badly hurts the Latin American economies; the dumping of U.S. cotton abroad is one example.

Developing Good Public Relations. Most people agree that good public relations helps a company progress. Therefore, here are four quick tips which will certainly help you achieve better relations with our Latin neighbors.

Tip 1: Know the Language. It is clear that a German engineering firm would not operate too long in this country if the staff could not speak English. But one important American engineering firm has maintained a staff in Mexico for years yet not one member can talk Spanish. Mainly because of World War II, most foreign investments south of the Rio Grande have been from this country. Now, however, European firms are constantly increasing their share of the market.

Since the basis of communications and understanding is language, to know it is a must. Good public relations—and better business—will be achieved only if foreign firms are, at least, partially staffed with employes knowing either Spanish or Portuguese—whichever applies.

Tip 2: Know the Customs. American tourists know that they have to be acquainted with the country they are visiting to enjoy it better. The staff of American firms will also enjoy the trip and build up a better understanding—and business—if they are familiar with the history and customs of the country. For instance, your wife would be quite out of place if she would go downtown Buenos Aires wearing shorts, and celebration of the National Independence day is a must. Also, south of the border, man is still boss. It is almost unlawful for him to go shopping or do the dishes. Therefore, know the history and customs of the country.

Tip 3: Study the Country. A question can often be embarrassing. A Peruvian would certainly feel uncomfortable if he would be asked whether his country has a university, for as we know, the San Marcos University of Lima, founded in 1551, is the oldest on this continent. Therefore, do not ask questions that show how little you know about them. Study the country first.

Know the customs

Tip 4: Be Socially Active. It is amazing how some basic principles on public relations are forgotten by companies operating abroad. For instance, it is natural that executives and representatives of the company be socially active in the community in this country. But in many instances, this is quite the opposite abroad.

Although we all owe something to the community we live in, in Latin America it is common knowledge that the "socially unknown" are the Americans. However, it is clear that without a knowledge of the language and customs of the country, you can not become socially active. This is why this *tip* was mentioned last. Just remember to try to do as much good abroad as you would in your home town.

Where to Learn. An organized training program for Americans going abroad is probably ideal. Since language is a must, the selected personnel should be familiar with the foreign language. Some should speak it rather fluently.

To help employes going abroad there is an Institute in Phoenix, Ariz., which offers a training program on the language, history and customs of foreign countries. There is also one in New York City which will lecture members of foreign firms on the language and history of Brazil.

In addition, there are several books on Latin America that give the reader a good knowledge about its customs and history, like "Inside Latin America," by John Gunther and "Latin-America: A Modern History," by J. F. Rippy.

Employing Nationals. Finally, many companies have found it is good business to fill positions with as many Latin nationals as possible. In the case of Mexico, in particular, the old legend of lack of qualified technical people is no longer true and if they are well paid, they will be found.

Public relations is a part of any business. With U.S. investments in Latin America growing, public relations in these countries should be improved. Increasing European investments are a new challenge to U.S. firms.

When going to Latin America, you should be genuinely interested in the people and speak their language. Try to interpret Latin America with a Latin-American point of view.

About the Author

Thomas Garcia-Borras is a research chemist working in the research and development of linear polyolefin processes. Holder of a chemistry degree from the University of Mexico, he also studied chemical engineering in 1955 at The Rice Institute. Garcia-Borras has seven years experience in various phases of the Mexican chemical industry, and since 1956 has been in the Research Department of a large chemical company in Texas City. He is a member of ACS.

The Violent Nature Of Detonations

Major disasters due to hydrocarbon detonations are becoming more and more frequent. Here is some information which will help you distinguish between "normal" explosions and detonations—and how to avoid both

R. B. Jacobs
Standard Oil Company (Indiana)
Whiting, Indiana

A REVIEW of the major disasters caused by hydrocarbon explosions indicates that detonation-type explosions have accurred more frequently in recent years than in the past. An examination of the factors promoting detonations suggests that if flammable mixtures are permitted to exist within large, modern refining units, detonations are more apt to occur than they were with older, smaller units. However, experience also shows that old units and small equipment can detonate.

To begin with, let us simply point out that detonative explosions are a particularly violent type of explosion which takes place under certain conditions we can only roughly define.

Major Detonations. In Table 1 we have plotted all major hydrocarbon explosions with which we are familiar and which we believe to have been of the detonative type. By "major" we imply a minimum of about $1 million financial loss or multiple loss of life. We have also plotted separately those disasters where hydrocarbon detonations involved liquid oxygen. Regardless of whether these latter are counted, it appears that major disasters due to hydrocarbon detonations are becoming more frequent.

Part of this may be only apparent and possibly due to a greater knowledge and awareness of detonative phenomena in recent years. How-

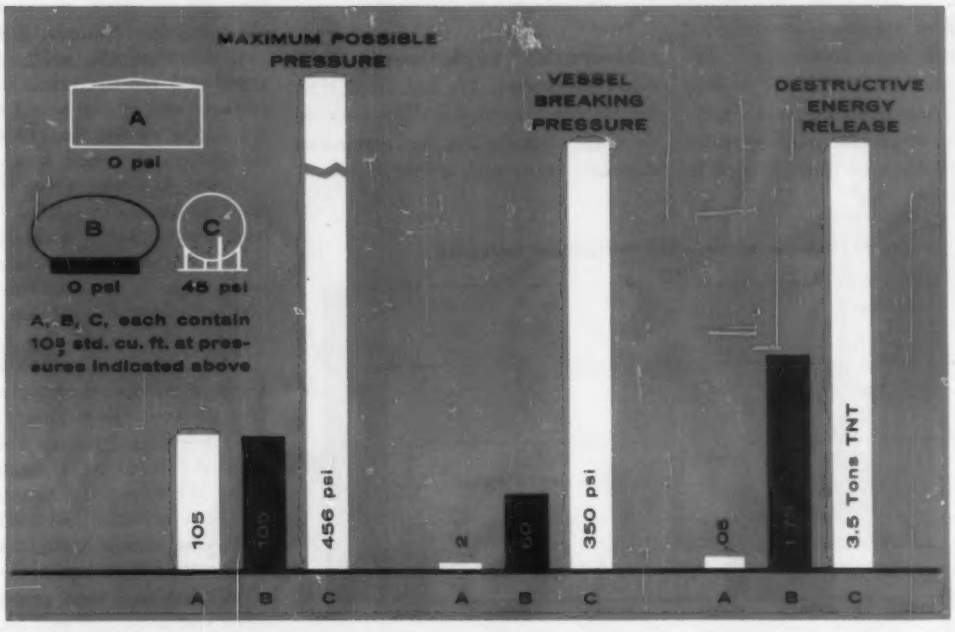


FIGURE 1—A weak containing vessel will fail long before it reaches maximum pressure.

Detonation fronts will travel at supersonic velocities

ever, this is by no means the whole story. Therefore, we believe it is most important that those concerned with the design and operation of plants handling hydrocarbons be fully aware of what detonations are and under what conditions they can occur.

"Normal" Explosions in Gaseous Mixtures. When explosions take place "normally" (without detonation) it is possible to calculate approximate values for:

1. The maximum pressure which can be generated,
2. The destructive energy released.

These quantities are plotted in Figure 1 for three different cases: a cone roof tank, a spheroid, and sphere, each containing the same quantity of a given flammable mixture. The values given are maximum theoretical; in the average case they would be about one-half as large as those indicated.

Notice that where the containing vessel is weak, as is the cone roof tank, the vessel fails long before reaching maximum pressure. In this case, the explosive process is quite inefficient in producing destructive energy. Since cone roofs are designed with a weak angle attachment (Figure 2), the roof will lift readily when an internal explosion takes place so as to protect the side walls. The record for such tanks is good in the sense that in all cases, with one possible exception, of internal explosion known to us they have failed at a low pressure by lifting their roofs and as a consequence side wall and external damage have been relatively minor.

As we will show later, apparently the size and geometry of present day oil storage tanks has been such that no detonations have taken place. If storage tanks were to be built in larger sizes, it is by no means certain that detonations would not occur or that an easily lifted roof would serve to limit damage as it now does.

Referring back to Figure 1, it can be seen that as the containing vessel becomes progressively stronger, the destructive energy release becomes greater. Thus it is possible even with a "normal" explosion to release considerable destructive energy. Parenthetically, we note here that "normal" explosions as well as detonative explosions have been responsible for major disasters. It is not our purpose to assign the role of destruction exclusively to detonative explosions, but rather to promote a greater general understanding and awareness of the phenomenon of detonation.

"Detonative" Explosions in Gaseous Mixtures. We indicated that for "normal" explosions it is possible to make calculations for maximum destructiveness with a fair degree of certainty. We do this for "normal" explosions by assuming equilibrium conditions, both chemical and physical. Now when a detonation takes place, burning proceeds with such rapidity that there is practically no time for mixing or pressure equalization and hence conditions are far from equilibrium. In fact, "pressure piling" and discontinuous shock waves are the very essence of a detonative type of explosion.

In Figure 3, you can see the terminal stage for a "normal" explosion and for a detonative explosion as each proceeds from the same starting conditions. Three characteristics of the detonative explosion that make it particularly destructive are:

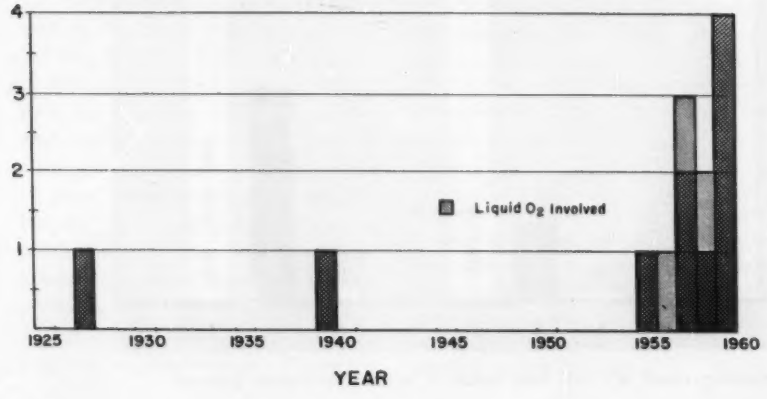
1. It produces a peak pressure which may be as much as 20 times the peak pressure produced by a "normal" explosion.
2. The detonation front travels at supersonic velocities, which makes pressure relieving devices useless for the most part.
3. The detonation exerts a directed blow rather than a hydrostatic force. This directed blow is often particularly damaging.

Devastating Blow. When "normal" explosions occur in weak vessels, the destructive process is inefficient, and the resulting damage usually quite small. However, this is not necessarily true for a "detonative" explosion for reasons which perhaps by now are apparent. Namely, if a detonation develops, the walls of a weak vessel may not have time to fracture and get out of the way before they are hit a devastating blow by the oncoming detonation wave.

Figure 4, drawn from two actual cases, illustrates this point. The cone roof tank exploded without detonating, lifting off the roof, and a large percentage of the explosive energy was exhausted harmlessly into the air. In the case of the gas holder (perhaps an equally weak vessel also designed to operate only at a very low pressure) the evidence indicates that the peak pressure was many times the breaking strength of the vessel. We believe this situation could not have occurred without a pressure shock which is characteristic of a detonative-type explosion.

We indicated that pressures may differ widely at different locations in an enclosure subjected to an internal

TABLE 1—Major Hydrocarbon Detonations Increasing



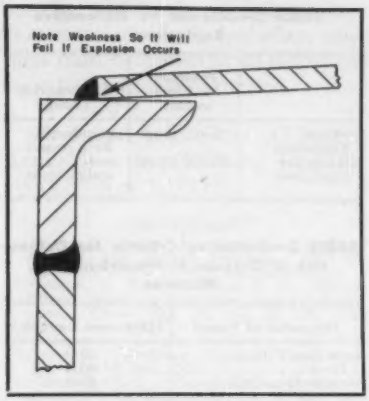


FIGURE 2—(Above) When an internal explosion takes place in a cone roof tank, the weak angle attachment enables the roof to lift, thus protecting side walls.

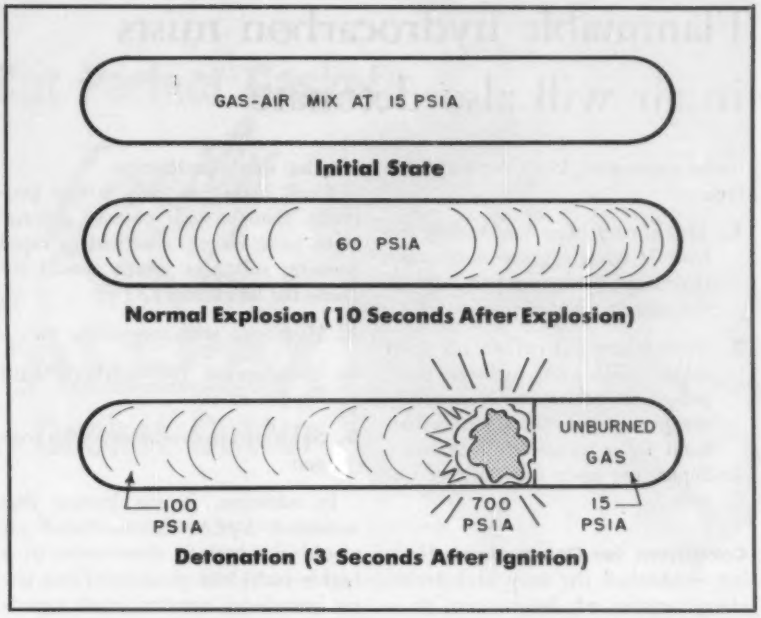


FIGURE 3—(Right) As a normal explosion and a detonative explosion proceed from the same starting conditions, the detonation reaches a much greater pressure more rapidly.

detonation. This is dramatically illustrated in Figure 5, where the pressure only 25 feet away from an open ended pipe was sufficient to rupture the pipe (about 6,000 psi). This emphasizes the futility of relief valves or other pressure relieving devices against detonative explosions.

Peak Pressures. In the section on "normal" explosions we stated that approximate values could be given for peak pressures developed from given initial conditions. In the case of detonative explosions the problem is far more complex. In "normal" explosions, measured peak pressures range from 3-10 times starting pressures (Table 2). In detonative explosions, however, we have measured peak pressures of more than 100 times starting pressures, although something more like 20 times would be more normal. However, to evaluate the real destructiveness of deto-

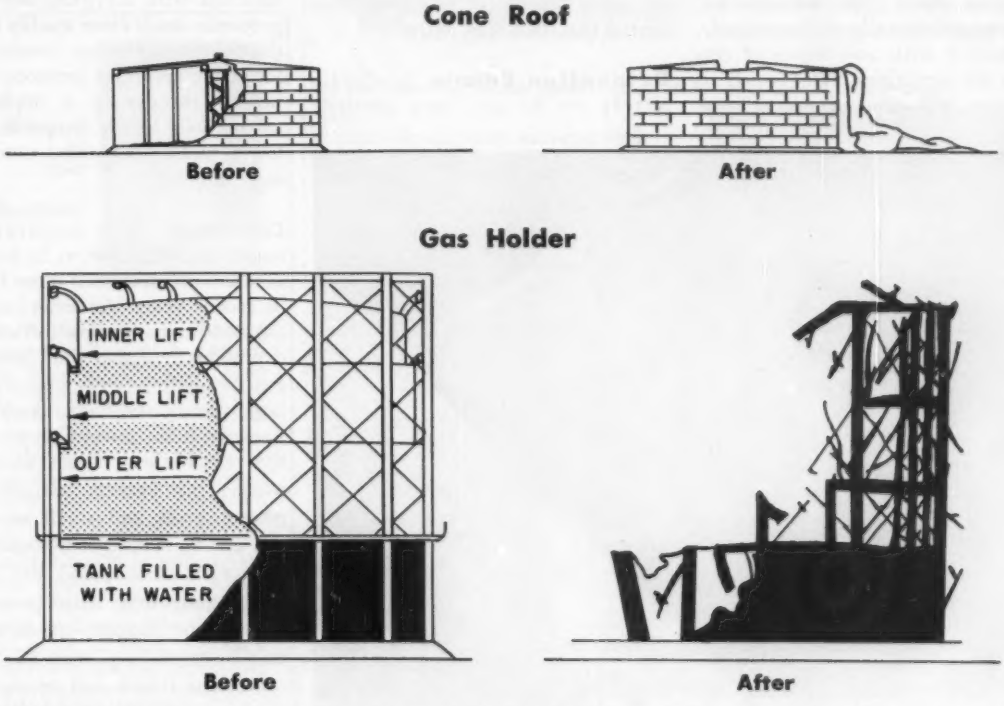


FIGURE 4—Normal explosion lifted roof from cone roof tank. Detonation, however, may demolish walls of weak vessel, as in case of gas holder.

Flammable hydrocarbon mists in air will also detonate

native explosions, keep in mind these facts:

1. The impact blow which they deliver is usually more destructive than a gradually applied force of the same magnitude.
2. Detonations are reflected upon impact with solid surfaces. Such reflections momentarily multiply the pressure in the detonation front by a value of 2 or more depending upon the angle of impact.

Conditions for Detonations. Having established the very undesirable characteristics of detonations, it is natural to ask under what conditions they are likely to occur. At the present time we are unable to give an exact answer to this question. There are two reasons for this. The first is that detonations are a non-equilibrium phenomenon and are somewhat ephemeral in nature. Even under laboratory conditions it is sometimes difficult to get repeatable results. The second reason is that not enough is known about this phenomena, either experimentally or theoretically, to establish with any degree of certainty the conditions under which an explosion will proceed normally or develop into a detonation.

Until rather recently it was generally thought that gaseous detonations were largely confined to rapid burning mixtures which would include the following:

1. Hydrogen with oxygen or air
2. Unsaturated hydrocarbons with oxygen or air
3. Saturated hydrocarbons with oxygen

In addition, it was known that saturated hydrocarbons and air would detonate if these were in a highly turbulent condition. This latter knowledge resulted from experimental work investigating a number of pipe line explosions which exhibited an unusual degree of violence.

Now we believe that almost all flammable gaseous hydrocarbon-air mixtures can detonate. We know further that flammable hydrocarbon mists in air will also detonate, although only two or three years ago lively debates were held on the subject of whether hydrocarbon mists in air were capable of anything more destructive than slow burning

Detonation Criteria. Unfortunately we do not know precisely under what conditions any mixture will detonate. With considerable trepidation then, we suggest the tentative geometric criteria shown in Table 2. These criteria apply only to saturated hydrocarbons beginning at atmospheric condition in a non-turbulent state.

Apparently if a high degree of turbulence is present, only a few feet are required for the development of intense shock waves. Furthermore, if unsaturated hydrocarbons or hydrogen are involved, or if the air is enriched with oxygen, detonations proceeds much more readily than indicated. Also, higher pressures and lower temperatures promote detonations. Conversely, a depletion of oxygen or a higher temperature or a lower pressure make detonations more unlikely.

TABLE 2—Normal vs. Detonative Explosions

	Pressure Multiplication	Destructive Energy
Normal Explosions	3-10 times	insignificant-20% (max.)
Detonative Explosions	20-700 times	never insignificant

TABLE 3—Tentative Criteria for Detonation of Gaseous Hydrocarbon*-Air Mixtures

Diameter of Vessel	Minimum Length**
Less than 1 ft	10 ft
1 ft—3 ft	40 ft
Greater than 3 ft	25 ft

* For saturated hydrocarbon types starting at atmospheric, non-turbulent conditions.
** Length inversely proportional to (pressure)2/3;
Length directly proportional to (temperature)2/3.

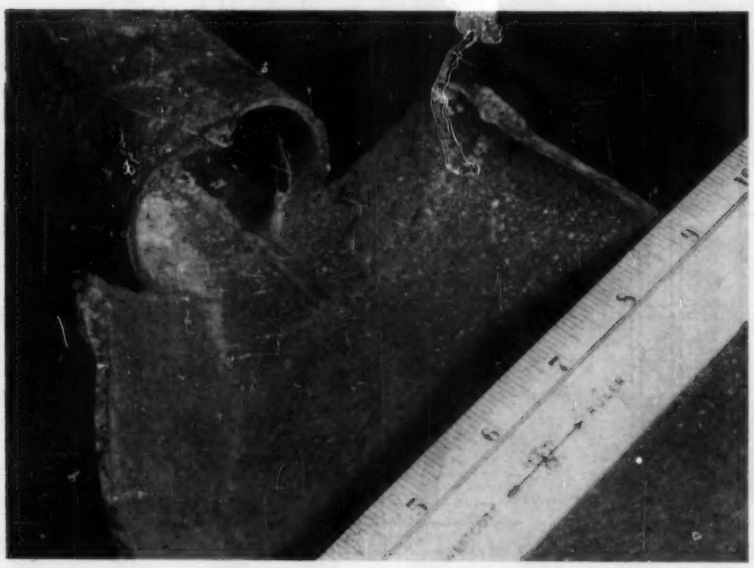


FIGURE 5—Futility of relief valves and other pressure relieving devices illustrated when pipe was ruptured by pressure although open end was only 25 feet away.

Conclusion. It is apparent that major disasters due to hydrocarbon detonations have been more frequent in recent years. An examination of the conditions leading to detonative explosions indicates that large modern installations with long pipe runs, large vessels, and high velocity vapor lines are more susceptible to detonative explosions than were older smaller installations, although old process units and small equipment can also be subject to detonation.

In view of this, and also in view of the great destructive potential of detonations, disasters can be avoided only by carefully guarding against all conditions which can result in the presence of flammable mixtures within operating units. If air or oxygen

must be used in the refining process, its concentration in hydrocarbon mixtures must be known at all times and must be rigorously controlled.

(Presented before the API 39th Annual meeting, Refining Division, Chicago, Nov. 9, 1959).

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About the Author

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Try This Approach to Plant Problems

All during your career you will be coming up against different types of problems—here are some pointers on how to go about solving them

E. F. Voss
Humble Oil & Refining Company, Houston

MY COOKBOOK gives the following recipe for the mental attitude needed when approaching a refinery problem: take a nickel's worth of optimism, about the same amount of confidence, and two dollars' worth of skepticism. Don't mix the ingredients. Wear the optimism like a flower in your buttomhole for all to see. Use the confidence to get started on the problem; but keep the skepticism in your pocket for handy use. You will probably need it all through the job.

It will be useful when your research organization says a process has been completely worked out and is ready to be translated into steel and concrete; when management says a job will be released to you on a certain date.

You should be wary when the contractors tell you how good they are and how much experience they have had with the kind of plant contemplated; when the equipment vendors praise the excellence of their products and make promises of quick delivery; when you are told that a certain detail won't work, because it was tried unsucessfully at some other refinery; or when somebody says: it will be easy, it won't take long, it won't cost much. But if you are the least bit like me, you better reserve a lot of skepticism for your own pet ideas.

I have had many arguments with other engineers. Some of the arguments have been anything but mild, but they are nothing compared with those I have had with myself. Now—please note that I said skepticism—not pessimism, and I did not imply that any of the parties mentioned were insincere or would knowingly give you bad information. But a research man must, of necessity, be optimistic, and if a salesman is not sold on his product, how can he expect to sell it to you.

Get the Facts. So much for your mental attitude—now for the preliminary work of how to approach a refinery problem. First determine exactly what is wanted, what previous work has been done on the problem by your company, how far you are to carry the problem and what use will be made of the finished work. You should also check to see what data are available, what help you can expect from other departments as well as from your own, what latitude you have, and how much time and money are allotted.

From this information, you should be able to make a preliminary time schedule. If this time table runs past the originally alloted time, and the deadline cannot be extended, you will have to go back over your schedule and cut enough corners to leave a little time to spare for unforeseen difficulties.

When the preliminary survey is completed, the actual work can start.

Be Critical. There are limits to what can be said in a general way about how to proceed, because the problems vary greatly in kind and scope. A few warnings are, nevertheless, appropriate: you should examine critically all your assumptions, the data given you by others or extracted by you from different sources.

This may sound elementary, but some of the most embarrassing situations I have witnessed resulted from a failure to observe these precautions. For example, a university professor wrote a learned and lengthy mathematical paper on distillation. All the work that went into the paper was wasted, because on the first page he incorrectly assumed that chemical equilibrium existed between the different hydrocarbons at the relatively low temperature at which the distillation took place.

Another case concerns an engineer who figured the savings which would be realized by replacing doctor sweetening with another process. But he failed to find out that the cost given in our cost book for doctor sweetening included the cost of a caustic prewash which could not be eliminated.

Our inspectors once reported that an emergency replacement, with less-suited material, had to be made to the piping of a large refinery unit because the accelerated rate of corrosion would not allow us to wait for delivery of the proper material which was on order. All calculations were checked and found correct, but when the metal temperature, which had been reported by another department, was checked by measurements, it was found to have been overestimated. Consequently, the old piping could last until the next turnaround.

The piping did not fail and later was replaced with the proper material. The saving was well over $100,000.

Question of Safety. In most design problems the question of the factor of safety—or, if you prefer, factor of ignorance—must be decided. There are probably as many ways to select a factor of safety as there are designers. If a design passes through successive engineers or groups of engineers, it is, of course, necessary to avoid piling factors upon factors. Personally, I am in favor of using different factors for different parts of a unit. The circumstances that, in my opinion, would contribute to the selection of a higher factor of safety would be:

- Uncertainties as to the quality of the data or method of calculation.
- A high penalty resulting from under-design.
- A high future payout of the extra capacity due to over-design.

If it is necessary that the unit be capable of operaing at full capacity after a few weeks of operation instead of after some months, the factor of safety normally should be increased.

I have been told that when an experienced burglar enters a house, the first thing he does is prop open the rear door for an easy exit. In design work, it is also advisable, at times, to leave the back door open; that is, to decide on what additional equipment would be needed if certain assumptions or calculations went wrong, and then leave room on the plot plan for such equipment. If skillfully done, it need not be expensive and while it may not be needed, you will be able to sleep better.

Finding the Answer. While most of our work falls within the province of our knowledge, frequently an engineer comes up against a problem unlike any others with which he is familiar. The time-honored adage advises: first, ask somebody who knows; failing in this, look it up in the literature; as a last resort, work it out experimentally.

This advice sounds better than it is, because how do you determine who actually knows the answer; and when you turn to the literature, you may find a number of contradictory articles, or sometimes just one article authored by a man who has made only a few experiments and has written 20 pages of theory. As to information obtained by experimentation, it also is subject to errors and misinterpretations.

It is not my intention to place all the world's troubles on your shoulders but only to point out that at times you can do yourself and your company some good by using your native intelligence and whatever theory you can remember. At least, back off from the subject and take one good hard look at it to see that the solution does not fly in the face of common sense.

Which Method? So far, I have touched only upon the approach of the individual engineer to refinery problems. A few decades ago this would have been sufficient, but the increase in the complexity of the refining business has made it necessary —in more and more cases—to resort to the combined effort of engineers from different branches of the profession. On many large jobs, the question becomes: how can an engineering organization best approach a refinery problem; how can it capitalize on the advantages, and how can it minimize the delays characteristic of group action?

At one extreme, the job can be handled by a committee on which all branches of engineering are represented and which has each member present at all decisions. At the other extreme, one man can be assigned to the job to refer the individual problems, as they arise, to the proper group or individual specialist.

The first method is wasteful of manpower, if for no other reason than that an engineer cannot be divided into fractions and such a group is apt to spend its time arguing instead of acting. The second method relies on the ability of one man to recognize when he needs help and also on his ability to evaluate and arbitrate the conflicting views of the different groups.

In the past, we have followed the second course for our small jobs. For larger jobs, we have taken a middle course by assigning two engineers—one a process engineer and one a mechanical engineer—to act as a committee. Each takes care of his particular specialty, but the two work closely together and inform each other about actions taken.

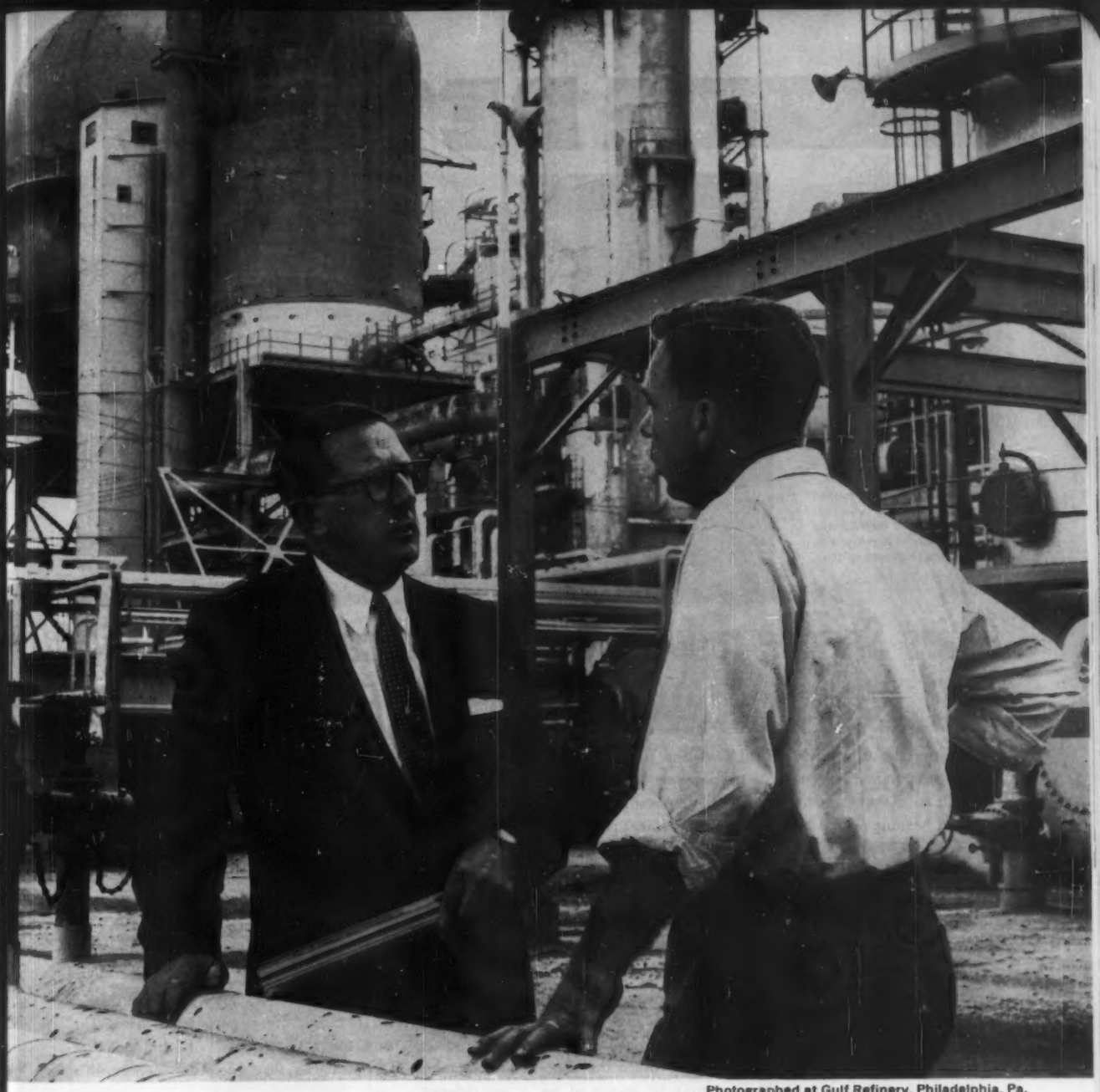
Such problems as instrumentation, machinery selection, and metallurgy are handled by assigning specialists from the individual engineering groups on a temporary basis to work with the two-man committee. This works fairly well although, from time to time, something slips past one of the two committee members, and sometimes they fail to recognize that certain matters should have been referred to a specialist. This, of course, happens more frequently when it is necessary to assign relatively inexperienced engineers to supervise the job.

Communication Difficulties. The problems of coordination and communication are increased when a unit is designed in cooperation with an outside engineering firm, because there is the added complication of distributing information received by the contractor to the different engineering groups inside its office. The more departmentalized the individual engineering organizations are, the greater the difficulty of communication.

This brings up the question of how to select and train the engineers who are to coordinate the large engineering projects. One way is to let them make their mistakes in the hope that they will not repeat them. Another way is to attempt to convey the experience of the organization as a whole to the individual members. The last objective can, perhaps, be attained by holding seminars where special problems and, if possible, their solutions are discussed briefly.

Another way is to conserve and pass on engineering experience and know-how through standards and standard procedures. This is a simple way of subjecting small but recurring problems to group study. The proposed standard is prepared by a group specializing in such work, but before it is accepted, it is sent for comments to all interested parties and discussed with them. When an agreement is reached and a standard is signed by the chief engineer, it becomes binding on all parties. The individual engineer should, however, suggest any changes which seem warranted.

Speak Up. We have already discussed the necessity of cooperation and team work between engineers and groups of engineers. Unless handled carefully, however, group deci-



Photographed at Gulf Refinery, Philadelphia, Pa.

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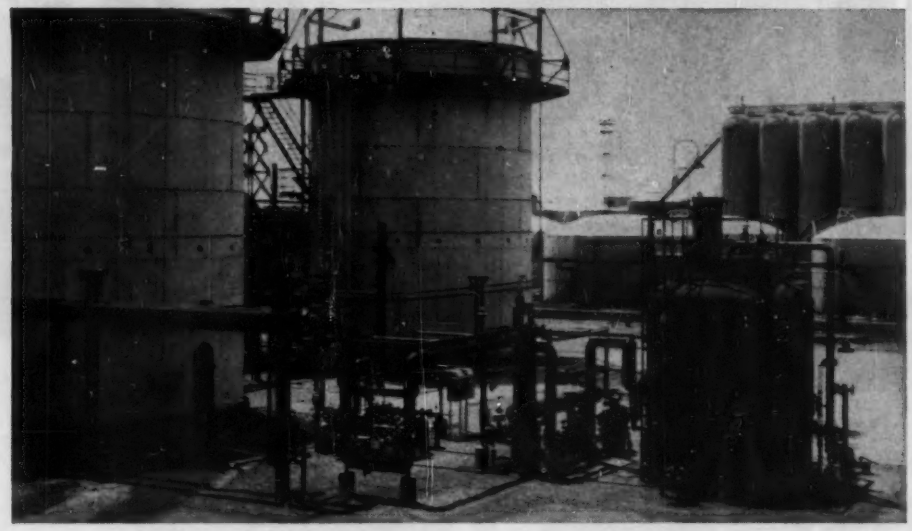

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sions can dull the initiative of the individual engineer and lessen his sense of responsibility. Some make such a fetish of group decisions that an engineer holding an opinion different from that of the group is considered disloyal. Remember though, that many of the greatest forward steps in science have been made by individuals who had to fight hard and long against the entrenched opinion of the learned fraternity.

The question, therefore, arises when, how, and how often should an engineer voice his dissenting opinion? I will have to leave the answer to the general question to the individuals, but the least that can be expected of an engineer, if he aspires to professional status, is that when his opinion is asked, he gives it without consideration of the answer which may be desired. However, once a plan is decided upon, the engineer will have to give his best even if he is not convinced that the best solution has been obtained.

In conclusion, I would like to say that I hope you will have as much satisfaction and fun out of refinery engineering problems with their triumphs and failures as I have had.

About the Author

Dr. E. F. Voss is chief refinery engineer for Humble Oil & Refining Co., Houston, where his duties are in consulting. He studied engineering in Germany and received his degree in that field from Massachusetts Institute of Technology in 1918—then obtained his Ph.D. degree in physical chemistry from the University of Paris. Dr. Voss previously worked for Lewis Recovery Corp., and taught chemical engineering at M.I.T., 1922-24. He has been with Humble since 1924.

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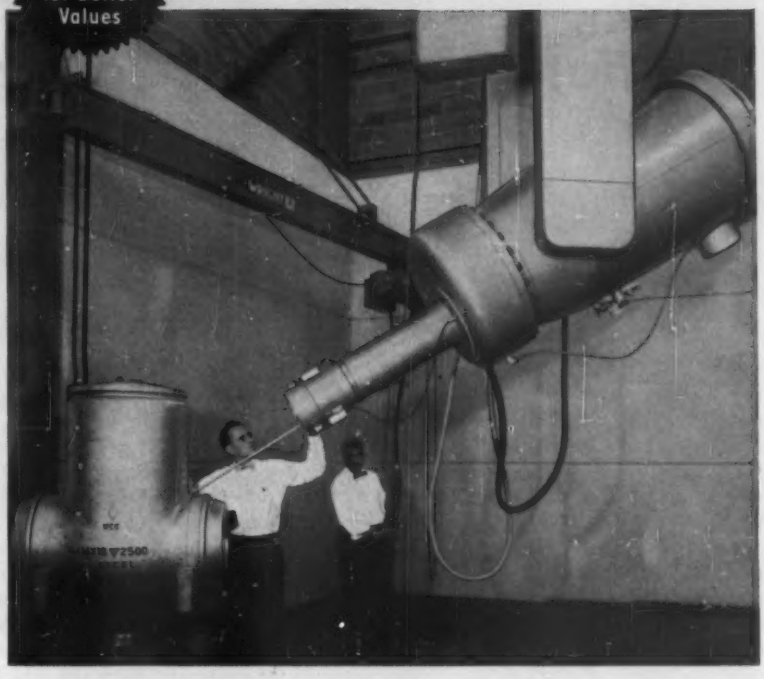

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What's Happening...

Refiners Find Ways to More Cat Feed

Catalytic cracking can now eat deeper into crude residue. AIChE papers tell how

FEEDSTOCKS for catalytic cracking was one of the big topics of discussion at the AIChE meeting in San Francisco, Dec. 6-9. It was reported that cat cracking, a comparative newcomer in the refining field, increased more than 450 percent from 1946 to 1958 while maximum refining throughput only doubled in the same period. Thus the recovery of all components of heavy vacuum residues which are suitable for catalytic cracking feed is one of the most urgent needs of the refining industry.

Information showing the improvement afforded to cat feed by hydrogen treating was given by representatives of several companies. Harold Beuther and Richard A. Flinn, Gulf Research and Development Co., Pittsburgh, described the advantages of hydrogenation in reducing the nitrogen and metals content of atmospheric and vacuum residues. Then the residues became as suitable as virgin gas oils for cat cracking. It would be possible also to apply the hydrogenation process and cat cracking to completely eliminate residual fuel production from the refinery, according to these authors. Thus the process becomes competitive with more conventional residue handling methods as the price of No. 6 fuel oil declines relative to crude and distillate products.

K. K. McMillin, Humble Oil & Refining, Baytown, Texas, described a number of treating techniques among which was the hydrodesulfurization of sour gas oils. He showed a credit for the pretreatment through increases in gasoline yield and octane quality and decreases in carbon yield. On the other hand British Petroleum Company representatives R. J. H. Gilbert and W. N. N. Knight, explained that the need for more cat cracker feedstock is not as great in England. Their requirements are very well met at present by vacuum gas oils. However, if more feed is needed, BP's data confirm the usefulness of hydrogen treating.

Many other methods of cat feed treatment were discussed at the AIChE meet. E. C. Herthel, E. H. Reynolds and J. H. Roe, Richfield Oil Corp., Wilmington, Calif., described the reduction in metals which could be obtained by giving careful attention to the vacuum distillation feed preparation unit to improve fractionation.

Techniques usually used to produce high quality lubricating oil stocks and distillate fuels were successfully adapted also to the task of upgrading feed stocks for catalytic cracking units. R. R. Dickinson and C. B. Longsworth, Texaco, Incorporated, Wilmington, explained how furfural refining increases gasoline production. The advantages of using propane deasphalting was told by John G. Ditman, Foster Wheeler Corp., New York. Then P. T. Atteridg and R. P. Cox, M. W. Kellogg Co., Jersey City, calculated that phenol extraction would pay out in about two years if used to treat decarbonized oils.

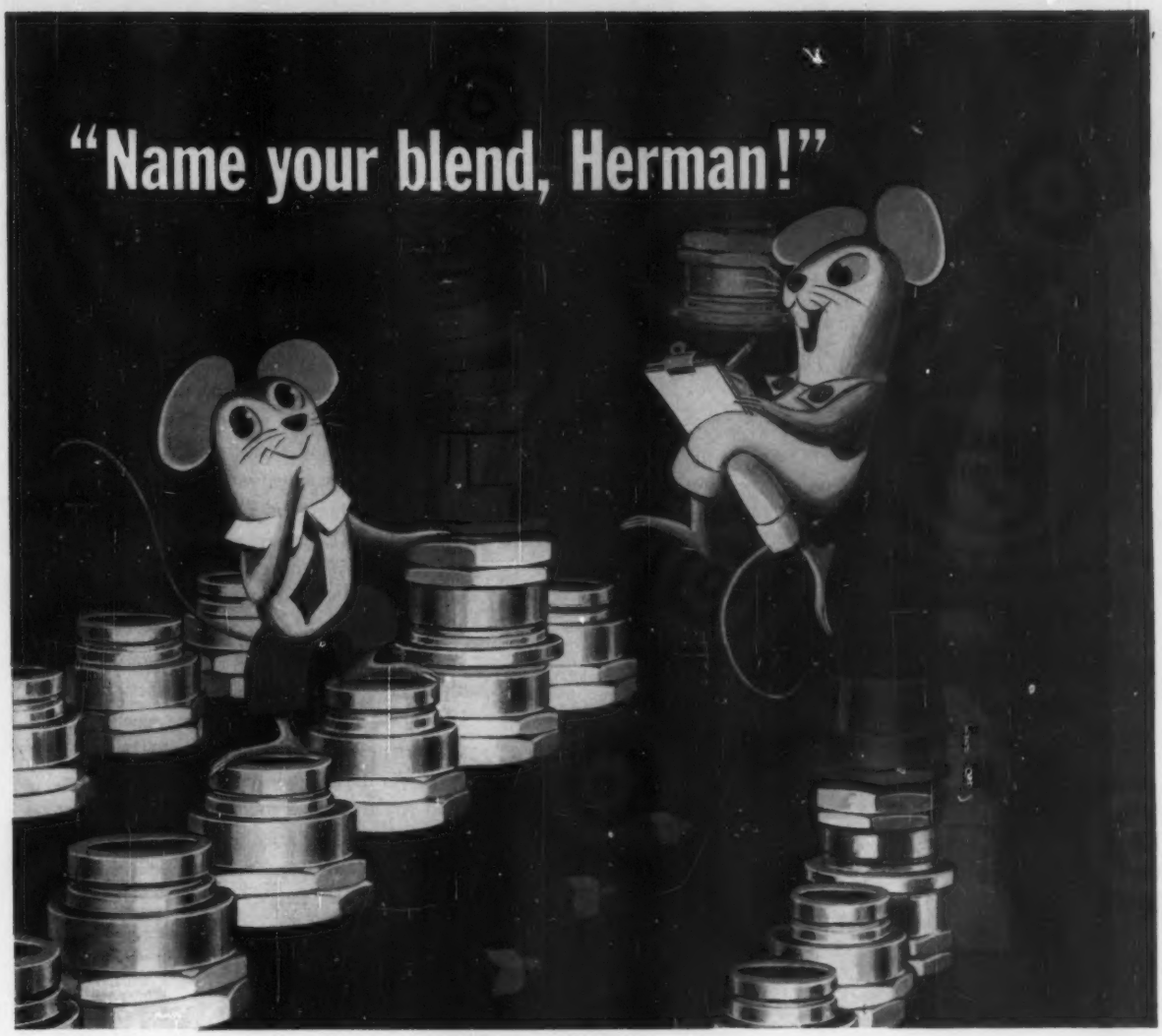
Correlations of product properties with variations of feed were also presented. R. L. Flanders, J. G. Girard, and B. D. Laughlin, California Research Corp., Richmond, believes an average boiling point is all that is needed to characterize the oil from a given crude. H. E. Reif, R. F. Kress and J. S. Smith, Sun Oil, Marcus Hook, added carbon distribution, naphtha content, and sulfur and basic nitrogen concentrations to the boiling point information for making an estimate of yield and octane of cat gasoline. Earl C. Gossett, Sinclair Research Laboratories, Harvey, Illinois, helped identify the harmful effects of nickel, vanadium and other metals on cat cracker operation.

REFINING HALL OF FAME
WILLIAM M. BURTON
Dr. William M. Burton (1865-1954) is noted for developing the first successful cracking process to make more gasoline from crude oil. In 1909 he perceived that gasoline demand was growing so rapidly that refiners would soon be hard pressed to meet it. He felt that manufacture by chemical change rather than by physical separation held the answer. The Burton processes' principles contributed greatly to modern refinery practice, and gave it that flexibility which enables it to adjust to market needs. For this, the API awarded Dr. Burton the Gold Medal for Distinguished Achievement.
SELECTED BY THE READERS AND EDITORS OF
Petroleum Refiner

Hall of Fame Plaques Hung In Drake Well Memorial

The January 1959 issue of PETROLEUM REFINER announced for the first time the names of those eight men who had been elected to the Refining Hall of Fame. In addition to being honored in that special Oil Centennial Issue, copper plaques bearing a likeness of each man would be hung in an appropriate place so all Americans would come to know these men who contributed so much to the industrial, economic and technological advancement of this country.

These plaques were recently completed and are now hanging in the Drake Well Memorial Museum, Titusville. The copper portion measures about 9 x 12 inches and is mounted on an 11 x 14-inch polished mahogany base. Pictured is the plaque for Dr. William M. Burton.



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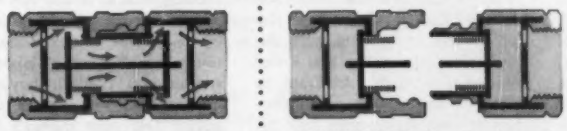

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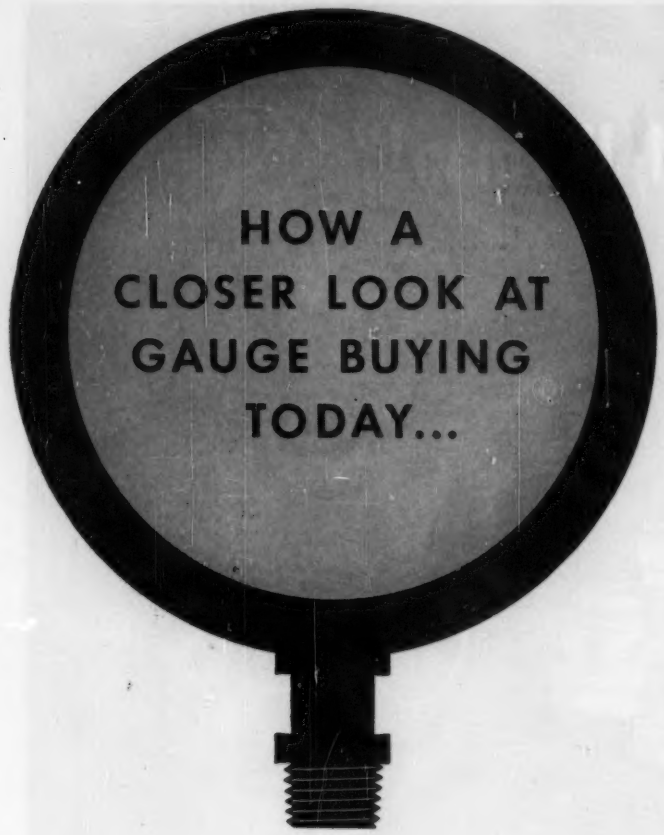

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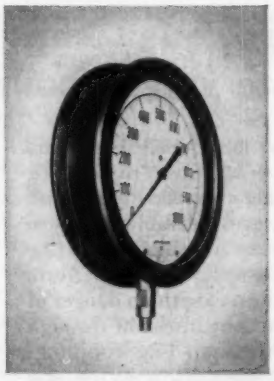

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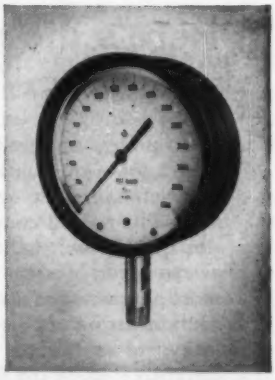

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Happenings . . .

Plant Maintenance and Engineering Show Planned

The largest Plant Maintenance & Engineering Show in the exposition's 11-year history will take place at Convention Hall, Philadelphia, January 25-28. Exhibit space will be 20 percent greater than last year. Four hundred companies will exhibit and about 20,000 visitors are expected from 30 countries. The show, one of the three largest annual industrial expositions in the country, will contain 10,000 different products, and is valued at about $7.5 million.

Following the show, 200 executives will gather in 10 Executive Study Groups to discuss major problems of maintenance in small, informal sessions, and to exchange information about recent developments in their respective companies.

ASEE College-Industry Conference Is Planned

On January 27-28, 1960, the Engineering School of Washington University, St. Louis, Mo., will be host to the Relations With Industry Division, American Society for Engineering Education, at its annual College-Industry Conference. This meeting brings together many leaders of both industry and engineering education to discuss common problems. This year the conference theme will be "The Young Professional Engineer—Our Mutual Responsibility." It is planned to discuss, as separate topics, responsibilites of the university, the graduate, industry, and the professional societies.

Those interested in attending or receiving further information should write to Don A. Fischer, Dean, School of Engineering, Washington University, St. Louis 30, Missouri.

Stresses Importance of Sound Government Policies

As long as sound government policies, both state and national, are maintained, domestic oil supplies will continue to expand in keeping with the growth in U.S. petroleum needs, Minor S. Jameson, Jr., executive vice president of IPAA said in an address at the association's recent annual meeting. He emphasized that of the four basic considerations on which the nation's future petroleum supplies are predicted, sound government policies are a controlling determinant.

"They have a direct bearing on the subject of future oil supply," Jameson said. "For example, long-established federal tax provisions, designed to recognize the unique characteristics of mineral extraction, have become an integral part of the economic structure of the petroleum industry."

Unfavorable changes in these provisions, he said, "could disrupt exploration and development activities, divert capital

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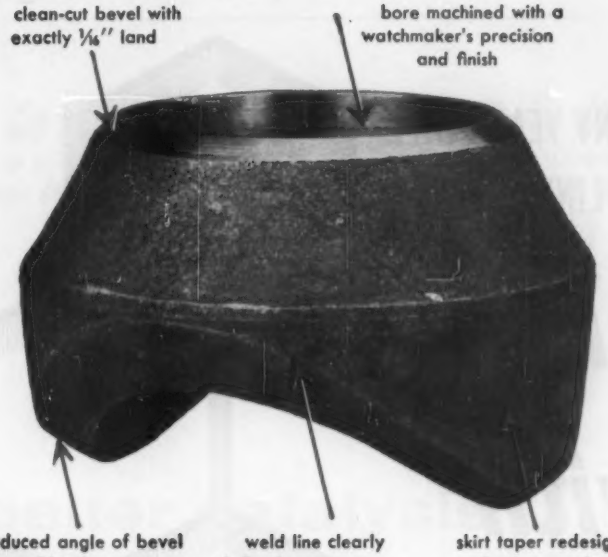
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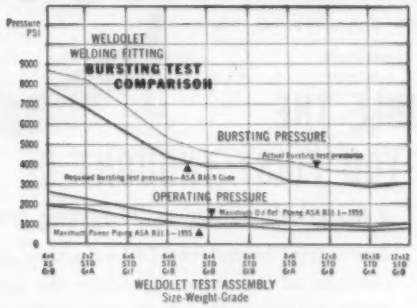

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resources to other fields, reduce long-term supply and, all other things being equal, increase the cost of oil and gas to the consuming public."

In addition, he cited the government's policy of limiting imports as a "key factor" in the outlook for U.S. oil supply. The United States must preserve "the productivity of our basic industries such as oil and gas."

The other three basic considerations which will determine, to a great extent, the long-range outlook for U.S. petroleum availability, the IPAA executive said, are geology, technology and economics.

'Test Tube' Highway for Indiana Standard

A new test-tube highway designed to help asphalt scientists pave the way to multimillion-dollar savings on road construction has been unveiled by Standard Oil Co. (Indiana). The miniature highway is a circle of paving only 12 inches wide and 44 feet in circumference. Four auto wheels whirl around the indoor track hour after hour, with only an electronic attendant in charge. Actual highway traffic conditions can be simulated, including speed, load, or weather.

Improvements in paving formulas can be tested quickly, and longer lasting, smoother, and safer highways will result, predicted S. A. Montgomery, manufacturing vice president. The road tester permits scientists to study within a few days what happens to a roadway in years of use and weather changes. Automated electronic equipment changes the conditions on the roadway rapidly from desert-dry heat into a cloudburst, on into freezing, thawing, freezing, and back to heat again. Effects of traffic on the paving under the controlled weather conditions are observed and recorded electronically.

API Data Show Operable U.S. Refining Capacity

A survey of operable refining capacity just completed by the API shows that, as of the end of this year, the industry expects to have daily operable capacity of 9,761,650 barrels. As of now, that figure is expected to reach 9,782,150 bpd by September 30, 1960. These totals are exclusive of 42,100 bpd which on September 30 last were shut down in need of major repairs, but include 522,850 barrels of capacity which, while operable, but believed to be in the high cost marginal group, were also shut down as of that date. For the country as a whole the September 30, 1959 figures shown in the table include about 95,150 bpd which is represented by crude oil charged direct to cracking units.

Domestic Fuels, Lubricants O.K. for Foreign Cars

Foreign cars operated in the United States perform very well on the fuels and lubricants available here. At the same

HOW MANY YEARS WILL A GOOD LINING LAST?

Make it with Hexmetal

AND DOUBLE THE NUMBER YOU FIRST THOUGHT OF

A lining lasts as long as its bonding properties.

The natural organic bond of refractory clays and the chemical set of concrete all fail eventually under the stresses imposed upon them. When a lining is "bonded" or given "bone" by Hexmetal Reinforcement, it holds in position long after all its natural bond is burnt out by heat or chemical action. The independent pinned joint of Hexmetal cells give twice the life of other reinforcements with lug joints.

Industry is year by year proving the value of these claims in Flues, Ash-Pits, Reactors, Cyclones, Cat Crackers, Coke Hoppers, Down Comer Pipes, Hydroformers, Water Turbine Flumes, Underground Galleries, etc.

CAUSEWAY REINFORCEMENT LIMITED

Five Ash Works · Dover Road East · Northfleet · Kent

Cables: HEXMETAL, GRAVESEND
Telephone: GRAVESEND 7871/3

For more data on advertised products, use Readers' Service Cards, last page.

Keys to better catalysis

. . . NORTON Ceramic Catalyst Carriers

In modern chemical and petrochemical process reactions, very often the choice of proper catalyst carriers is as critical a factor as selection of the catalysts themselves. And time and again, NORTON Ceramic Catalyst Carriers have proved the *best* choice both for efficiency and economy.

It's more than just a question of a quality product. There's a personal equation involved — the Norton Man. He brings to chemical engineers the benefits of NORTON COMPANY'S years of experience in the chemical and petrochemical fields as well as the end products of its advanced manufacturing and quality control methods. He *understands* the problems involved. And, backed by NORTON COMPANY'S extensive research and engineering facilities, he's well qualified to help in their solution.

Whatever the feedstock or thermal conditions involved . . . whether reaction is in the gaseous or liquid phase . . . whether the carrier is to be coated or impregnated with the active agent, he's ready to suggest the specific NORTON product that will do the job best. He also knows that *every* NORTON Carrier gives chemical processors the assurance of highest uniformity. From lot to lot — in any quantity — size, weight, porosity, pore diameter and purity are held to close tolerances that assure precise duplication of results.

Take advantage of the service the Norton Man represents. Let him help you to meet catalyst carrier specifications exactly. It's the simple practical way to insure maximum catalyst activity and life . . . to keep catalyst costs low . . . to get optimum yield from your process. Write NORTON COMPANY, Refractories Division, 471 New Bond Street, Worcester 6, Mass.

WIDE RANGE OF TYPES AS FOLLOWS

Shapes	Materials
Spheres	Alumina
Rings	Silicon Carbide
Pellets	Fused Magnesia
Granules	Zirconia
Powders	Silica, Zircon
	Magnesia — alumina Spinel, etc.

Porosity — from 10% to 50%

Surface Area — from less than 1 to 70 $m^2/gram$*

*BET Method

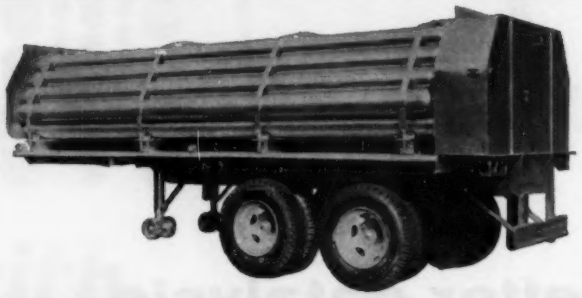
NORTON
REFRACTORIES
Engineered . . . Rx . . . Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — **BEBR-MANNING DIVISION** Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

For more data on advertised products, use Readers' Service Cards, last page.

NO STORAGE PROBLEM!



TW GAS TRANSPORTS

NOW YOU CAN MOBILIZE YOUR GAS STORES! At surprisingly low initial cost, Taylor-Wharton Gas Transports enable you to plan bulk storage for optimum flexibility. Available in capacities of 38,500 to 56,600 cubic feet, these ruggedly built units utilize storage pressure vessels made under the same controlled production methods that have made Taylor-Wharton and Harrisburg hot-drawn seamless cylinders world famous.

Each modern Taylor-Wharton Gas Transport consists of normalized seamless steel pressure vessels, inspected and tested to I. C. C. 3A-2400 specifications. The vessels are rigidly grouped and mounted on a special trailer chassis with either single or tandem axle. The transport is delivered ready for use, with tubes manifolded to a common outlet in a rear-mounted weatherproof cabinet.

You can use this transport to boost your storage flexibility — to have your gas *where* you need it, *when* you need it. For complete details, request catalog 58 today.

More than a Century in Harrisburg 2, Pa.

H HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

CYLINDERS TUBES FLANGES COUPLINGS

Happenings . . .

time, the durability of their engines is most satisfactory. These are the principal conclusions drawn from a survey of owners of imported automobiles conducted by Ethyl Corp. "The conclusions are particularly significant in view of the large numbers of foreign cars in use in the United States and the fact that American fuels and lubricants have somewhat different specifications than those on which most of the foreign cars were designed to operate."

More than 70 percent of the owners of higher priced sports-type foreign cars use premium grade gasoline, while more than 80 percent of "economy" model owners use regular. Satisfaction with fuel economy and the durability of engine parts—especially spark plugs, valves and mufflers—runs high among all owners.

Good Future Predicted For Conventional Fuels

Airplanes and other moving vehicles will use conventional fuels for power for years and "maybe for centuries" to come, predicted Dr. Edward Teller at a recent conference at Columbia University.

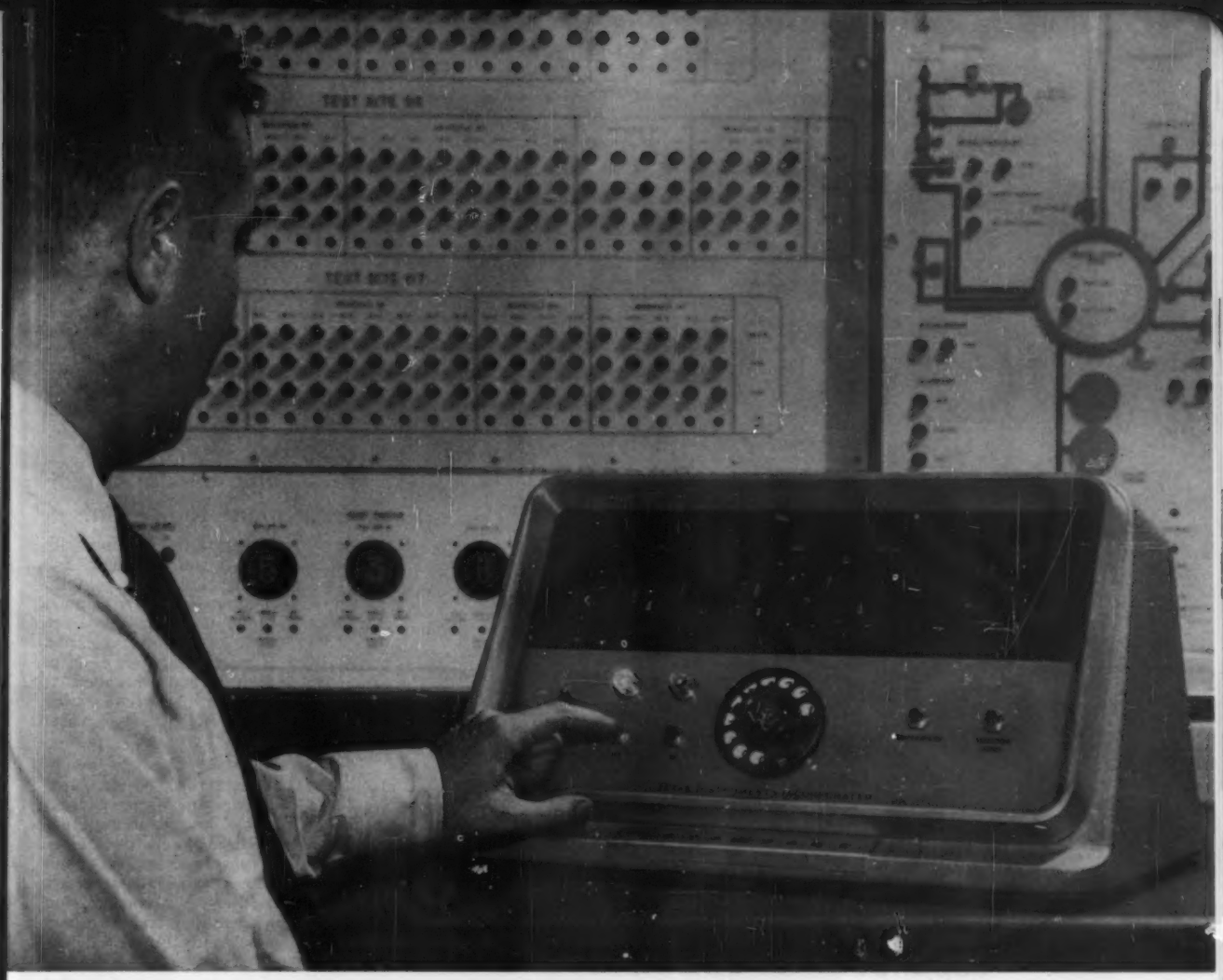
The noted physicist urged concentration on nuclear reactors as a source for stationary power rather than for machines that move. Teller was one of five speakers who participated in a day-long seminar on "Energy and Man" at Columbia University. The seminar was sponsored by the university and API. Other speakers took a similar view that petroleum and other conventional fuels would be major sources of power for years to come.

1959 Gasoline Production Put at 1.5 Billion Barrels

U.S. refiners will turn out about 4.1 million bpd of gasoline during the fourth quarter of 1959 to bring the total production for the year to a little under 1.5 billion barrels, according to an estimate by E. I. du Pont de Nemours & Co. At the same time, the company's Petroleum Chemicals Division forecast fourth quarter demand for gasoline at 4 million bpd, 2.5 percent higher than for the fourth quarter of 1958 but 312,000 bpd under the third quarter of this year. Most of the U.S. production will go into domestic use, with only 60,000 bpd expected to find its way into export channels during the current quarter.

On the basis of the forecast rates of gasoline demand and production for the fourth quarter, stocks at the end of 1959 would be about 193 million barrels or about 6 million barrels higher than the stock level at the end of 1958.

The increase of 2.5 percent forecast for total gasoline demand during the fourth quarter represents the smallest quarterly gain for 1959 over 1958, while the gain of 3.8 percent expected for domestic demand for motor gasoline is also



Use the only tank gauge system specifically designed for COMPLETE MEASUREMENT-ALARM-CONTROL

DATA-GAGE* is the only field-proved tank gauge system that provides the multi-purpose functions of measurement, alarm and control without extra, expensive control and selector equipment. And, it is the only system that performs all these functions with the high degree of accuracy and reliability you require . . . check these outstanding features carefully:

Accuracy — DATA-GAGE measures surface level to 1/16-inch accuracy in either stationary or floating roof tanks . . . is accepted for auditing purposes by major oil companies.

Reliability — DATA-GAGE CANNOT GIVE FALSE INFORMATION! All binary decimal code transmissions are automatically triple-checked before data is displayed. Float must break from the fluid surface to provide readout; point connections are verified from the field; polar code eliminates possible long-short ambiguity.

Versatility — *Same equipment* provides: digital and analog measurement including accumulator readout; control for motors, pumps, pilot valves, two- and three-position valves, adjustable chokes, controller set-points, etc.; alarm indication from any sensing contact. DATA-GAGE can be provided with automatic programmers, data loggers, alarm and status displays.

Capacity — Up to 1000 tanks can be measured for liquid level and temperature with one standard system.

Economy — DATA-GAGE has both low initial and long-range cost. No expensive extras are required. Code lines and power lines can be run in same conduit . . . often existing ground level gauge connections and pipes can be utilized. Transistors are used instead of short-lived vacuum tubes. Easy access plug-in units make this the easiest and safest to service of all systems.

For more detailed information on the DATA-GAGE, request Bulletin No. M-601. If you have any problems in remote measurement and supervisory control, TI application engineers can help you.

TEXAS INSTRUMENTS
INCORPORATED
GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS • CABLE: TEXINS

*Licensed under Sun Oil Company patents.

NEW!

LECTRODRYER® BUDGET AIR DRYER

supplies small quantities of dry air at low cost

If your requirements for very dry air are relatively small—but highly important—you'll find the new Budget Air Dryer tailor-made for your needs. An investment in large equipment is not needed. The Budget Dryer is modestly priced, easily installed and serviced, operates on any 110 volt a.c. line.

NEW BUDGET DRYER IS IDEAL FOR:

- air-operated instrument controls
- electronic equipment
- small cubicles
- pilot plant operations

This entirely new unit supplies up to 20 cubic feet per minute of air, dried to a dewpoint of −60°F or lower. Operation is completely automatic. Likewise, the unit is as foolproof as possible, operating independently of variations in air pressure. Rugged construction and a long operating cycle assure trouble-free use.

Lectrodryer Budget Dryers are standard units, available from stock, shipped ready for installation. For complete information on this new unit and its low cost, write for Bulletin B6A, Pittsburgh Lectrodryer Division, McGraw-Edison Company, 307 32nd St., Pittsburgh 30, Pa.

Lectrodryer McGRAW EDISON

Happenings . . .

the lowest for any quarter this year. However, this gain is still above the long range growth trend.

Again exerting a depressing influence on the growth in total demand are decreases forecast for domestic and export aviation gasoline demand during the fourth quarter. The daily domestic demand rate of 200,000 barrels of aviation gasoline forecast for the current quarter would be 10.3 percent under the fourth quarter of 1958, while the forecast export demand rate of 35,000 bpd of aviation gasoline would be 31.4 percent under the same period last year.

Digital Computer for Sun's Marcus Hook Plant

Simulating petroleum refining with the use of a new digital computer, Sun Oil Co. is getting answers to complex operating calculations in a few minutes that would require many days to solve manually. The secret of this accelerated mathematics is a magnetic-tape data processing system recently installed at the company's Research and Engineering Computer Center, Marcus Hook, Pa., refinery.

Work performed by this new equipment gives calculations on simulated processing conditions at both the Marcus Hook and Toledo, Ohio, refineries. Studies involve distillation towers, daily plant operating data, control performances and mass spectrometer analysis data. Other assignments produce information on service station operations and a variety of statistical calculations. Future calculations planned by Sun include optimization studies of the refineries, operations research work, engineering design and data processing, statistical analyses, and more complex and elaborate processing simulation.

November Octane Ratings Up 0.1 Octane Number

Gasoline on sale at service stations in November showed national weighted averages of 99.3 octane number for premium and 92.2 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

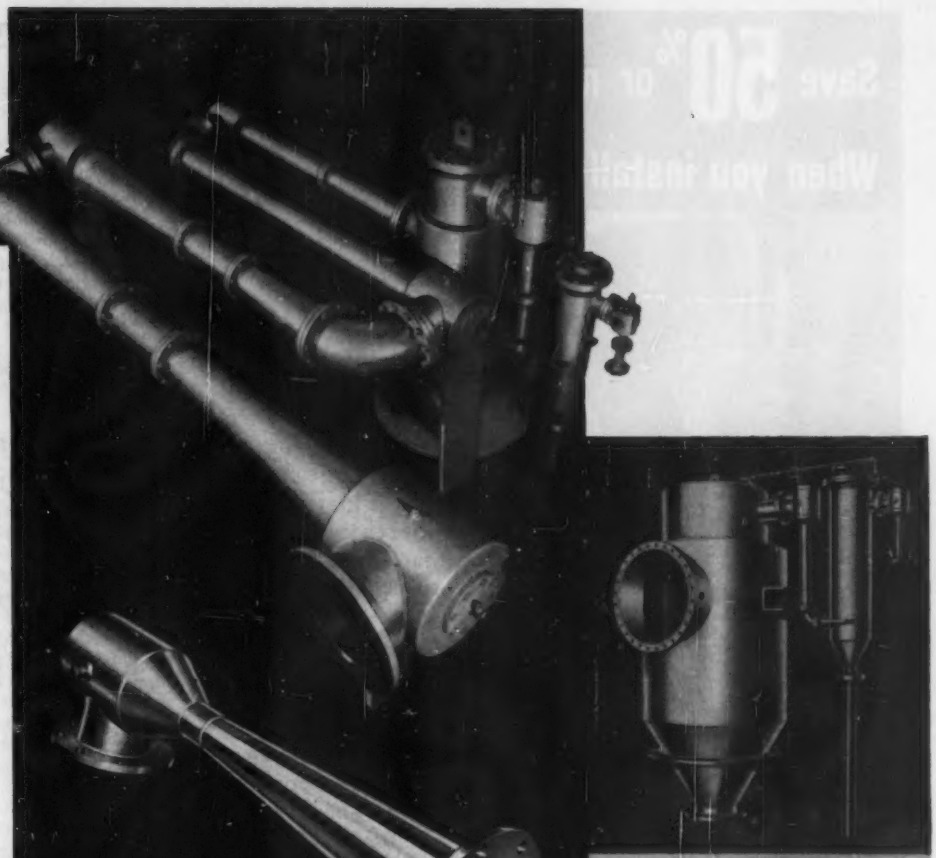
The regular average was unchanged from October but 0.7 higher than a year ago. The premium average was 0.1 octane number higher than in October and 0.5 octane number above a year ago.

Average tetraethyl lead contents in November were 2.48 ml per gallon of premium gasoline and 1.67 ml per gallon of regular gasoline.

Of the 57 cities in Ethyl's survey, 28 reported increases over October in the average octane number of their premium gasoline, one by 0.5 octane number. Nineteen cities reported decreases while 10 cities were unchanged. In regular gasoline, 27 cities reported increases over October in their average antiknock qual-

For more data on advertised products, use Readers' Service Cards, last page.

From Seven Stage to Single Stage



Graham direct contact condenser and 2 stage ejector—all of stainless 304 material.

—and available for immediate shipment!

We now offer you the finest performance available from one to seven stages——a few inches of vacuum down to one micron of absolute pressure—evacuating small or large loads. Graham ejectors are truly "second to none".

We have recently completed an extensive development program in our Batavia, New York engineering laboratory which has resulted in *added improvements* to the already high performance of Graham Steam Jet Ejectors. Design refinements worked out in this investigation mean increased stability, dependability and economy.

More information is contained in our Bulletin No. 70A. Send us your inquiries.

GRAHAM MANUFACTURING CO., INC.

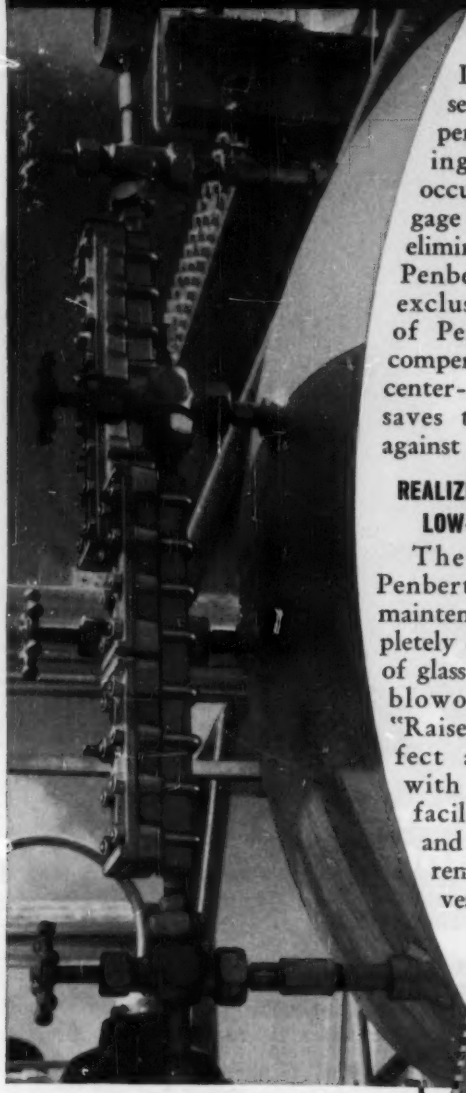
Heliflow Corporation

170 GREAT NECK ROAD, GREAT NECK, N. Y.

Offices in principal cities and Canada

Factory: Batavia, N.Y. Other Graham precision-built products: Heliflow Heat Exchangers, Monobolt Heat Exchangers, Deaerating Heaters, Surface and Barometric Condensers, Steam Vacuum Refrigeration, Aquamizer Evaporative Condensers.

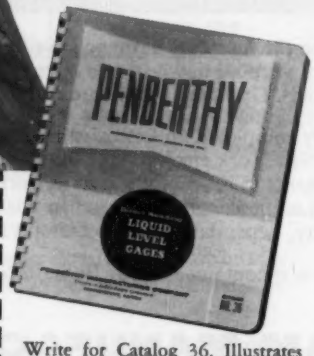
Save 50% or more
When you install PENBERTHY gage sets



Installing ordinary gage sets can be needlessly expensive and time consuming where inaccuracies occur in vessel tappings or gage assemblies. This is all eliminated when you mount Penberthy Gage Sets. The exclusive "Floating Shank" of Penberthy gage valves compensates for up to 3/8" center-to-center variation — saves time — and protects against mounting stresses.

REALIZE FURTHER SAVINGS IN LOW-COST MAINTENANCE

The unique design of Penberthy gages minimizes maintenance. The cover completely encloses sides and ends of glass and gasket to prevent blowouts. Full accessible "Raised Face" assures perfect alignment of frame with glass and gasket — facilitates cleaning, repair and maintenance without removing assembly from vessel.



Select the Right Gages for Your Requirements

REFLEX TYPE — 3 pressure groups to 3000 psig. Lengths to 12 ft.

TRANSPARENT TYPE — 4 pressure groups to 10,000 psig. Lengths to 12 ft.

SPECIAL SERVICE TYPES — High pressure, Frost-proof, Heating tube and Heating chamber, Welding pad, Large chamber and Inclined gages, Explosion-proof illuminator.

Write for Catalog 36. Illustrates complete line in detail including technical data, selection chart, specifications and properties, installation-maintenance instructions.

PENBERTHY MANUFACTURING COMPANY
Division of Buffalo-Eclipse Corporation
PROPHETSTOWN ILLINOIS

Happenings . . .

ity, three by 0.5 octane number or more. Twenty-three cities reported decreases while seven cities were unchanged.

Compared with the nationwide premium average of 99.3 octane number, three cities reported premium averages of 100 octane number or higher. In regular gasoline, 20 cities showed average octane ratings of 92.5 octane number or higher, compared with the national weighted average of 92.2 octane number.

For companies marketing more than one grade of premium gasoline, the survey showed a range of 100.3 to 102.4 octane number for the highest grade, on the basis of 48 samples in 27 cities.

Fort Worth Conference For Plastics Engineers

Plans are underway for the annual regional technical conference to be held April 20, 1960, at the Hotel Texas, Fort Worth, Texas. It will be sponsored by the North Texas Section, Society of Plastics Engineers. The subject is "Plastics in the Petroleum and Chemical Industries." The program will be offered in two concurrent sessions with papers being presented on both surface coatings and plastic structures, covering the most recent developments in both fields.

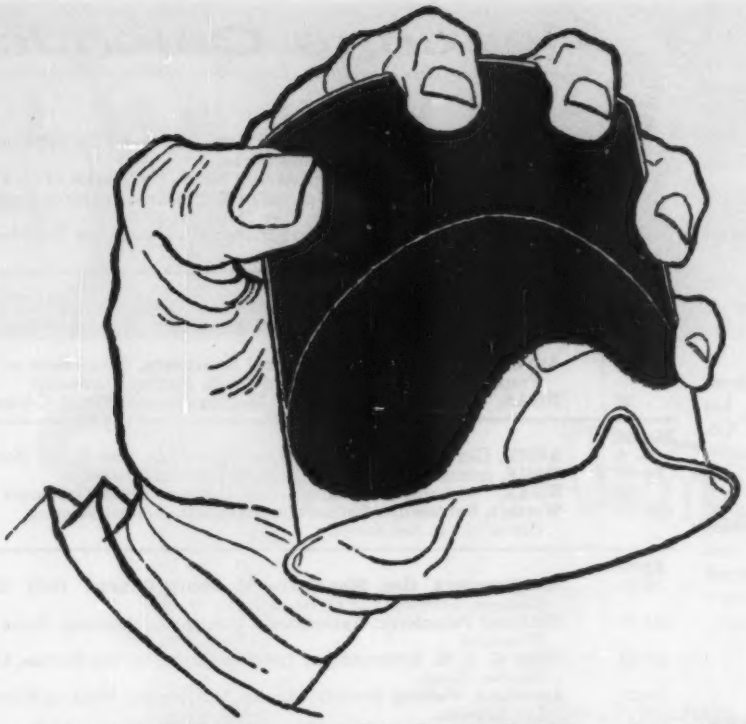
Program chairman, A. L. Barrier of Barrier Corp., and R. B. Bender of Tejas Plastics Materials, Fort Worth, said speakers and their topics will be announced later.

Computers for Atlantic's Philadelphia Refinery

One of the nation's newest electronic computers will be installed at The Atlantic Refining Co.'s Philadelphia refinery headquarters. The tranistorized equipment will provide the company with new levels of data processing power for a variety of purposes—from maintaining control of over 30,000 material and supply items to mathematically simulating the refinery's operation for experimentation. This computer system, a combination of the 7070 and 1401 data processing machines will be the first of its kind in an Eastern refinery when it goes into operation early in 1951.

Major Research Center For Stauffer Chemical

Construction of a major research center at Richmond, Calif., is planned by Stauffer Chemical Co. It will be located on a 10-acre tract recently acquired by the company adjacent to the present Richmond plant and research laboraries. Construction of the first unit of the new Research Center will begin in January. Completion of this initial laboratory, which will cost about $1.6 million, is scheduled for early 1961. Existing research facilities at Richmond will be used to expand process development and pilot plant activities.



X% IS PURE SULFURIC ACID...

but how do you salvage it?

Send a sample of *your* Spent Sulfuric Acid to Stauffer for analysis and report. You will benefit from the massive experience of the largest spent acid regeneration facilities in the country...larger, indeed, than all others combined.

These facilities enable us to store and process spent acid wastes from the manufacture of lube oil, naphtha, DDT, benzene, alkylation, alcohol, white oil, detergent and other chemicals or from other manufacturing operations. Long experience and proved methods enable us to blend quantities and varieties of acid wastes in compatible burning mixtures from which we recover water-white sulfuric acid. This is delivered to you by tank car, tank truck or barge ready for use at specified strengths precise to 1/10th of 1%.

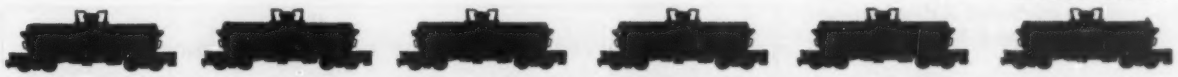
Contract regeneration of spent sulfuric acid eliminates your problems of acid separation and concentration, air and stream pollution and maintenance of equipment.

Let's get together and discuss your acid waste problem so we can make proposals regarding method of collection and shipment, regeneration point, rate and cost of recovery, etc. "If you can pump it, we can regenerate it!"

STAUFFER'S SULFURIC ACID FROM . . .

*BATON ROUGE, LA. • *BAYTOWN, TEX. • CORPUS CHRISTI, TEX. • FORT WORTH, TEX. • *HAMMOND, IND.
*HOUSTON, TEX. • LeMOYNE, ALA. • *LOS ANGELES, CALIF. • RICHMOND, CALIF. • TACOMA, WASH.

*Regeneration Plants.



STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, New York
Prudential Plaza, Chicago 1, Illinois — 636 California Street, San Francisco 8, California
824 Wilshire Boulevard, Los Angeles 17, California — P. O. Box 9716, Houston 15, Texas

CONSOLIDATED CHEMICAL INDUSTRIES DIVISION, 6910 Fannin St., Houston 25, Texas

For more data on advertised products, use Readers' Service Cards, last page.

—Changing Times—

Monsanto Chemical Co. has purchased 400-acre tract near Oxnard, Calif., 60 miles north of Los Angeles. Company has not disclosed plans for property.

Superior Propane, Ltd., has purchased Metro Gas, Ltd., Ste Anne de Bellevue, Quebec. Deal involves bulk and cylinder customers previously served by Metro.

British subsidiary of The Dow Chemical Co., Dobeckmun Britain, Ltd., has changed name to Dow Chemical Co. (U.K.) Ltd.

New research and development service for companies seeking to develop new commercial processes **has been formed by the M. W. Kellogg Co.** Company's R & D service will be on cooperative, contract basis.

Half of 30,000 U.S. secondary schools are using API school-program material, according to Institute's Advisory Committee on education. New student booklets in preparation deal with general science, chemistry, physics and mathematics.

New liquid chemical tanker will be added to The Dow Chemical Co.'s fleet in March. Vessel is company's third leased tanker.

Pure Oil Co. shut down its 37,500-bpd Toledo Refinery November 15-December 13 "to bring product inventories in line with a reduced seasonal demand."

API is second tennant moving into Rockefeller Center's 48-story Time & Life Building, New York. Formerly in RCA Building, association moved November 27-28.

Esso Standard Oil Co.'s Baton Rouge, La., refinery celebrated 50th anniversary with 12-day celebration ending November 8.

API concluded biggest annual meeting November 11. All-time-high registration hit 6,605, beating 1954 record by 128. Institute's 1960 and 1961 meetings will be in Chicago.

Meetings Calendar

Jan. 1960	
22	**Natural Gasoline Association of America,** Gulf Coast Regional Meeting, Robert Driscoll Hotel, Corpus Christi.
25–28	**Plant Maintenance & Engineering Show,** Convention Hall, Philadelphia.
28–29	**National Association of Corrosion Engineers,** Course in Practical Corrosion Control Systems, Rice Hotel, Houston.
31-Feb5	**American Society for Testing Materials,** Committee D-2 Meeting, Statler Hotel, Detroit.
Feb.	
1–5	**ASTM,** Committee Week, Hotel Sherman, Chicago.
21–24	**American Institute of Chemical Engineers,** Meeting. Hotel Biltmore, Atlanta.
23–26	**American Society of Mechanical Engineers,** Symposium on Thermal Properties of Gases, Liquids and Solids, Purdue University.
26	**NGAA,** Permian Basin Regional Meeting, Lincoln Hotel, Odessa, Texas.
March	
6– 9	**ASME,** Gas Turbine Conference and Exposition, Rice Hotel, Houston.
14–18	**NACE,** Annual Meeting, Memorial Auditorium, Dallas.
18	**NGAA,** Oklahoma Regional Meeting. Biltmore Hotel, Oklahoma City.
28–30	**Western Petroleum Refiners Association,** Annual Meeting, Hilton Hotel, San Antonio.
April	
19–21	**Southwestern Gas Measurement Short Course,** Drill Hall, North Campus, University of Oklahoma.
20–22	**National Petroleum Association,** Semiannual Meeting, Hotel Cleveland, Cleveland.
20–22	**Texas A. & M. Symposium,** Instrumentation for the Process, College Station, Texas.
25–29	**American Welding Society,** Annual Meeting and Welding Exposition, Los Angeles.
27–29	**NGAA,** Annual Convention, Rice Hotel, Houston.
May	
2– 6	**American Petroleum Institute,** Midyear Meeting, Safety and Fire Protection Committees, Atlanta-Biltmore Hotel, Atlanta.
9–12	**API,** Midyear Meeting, Division of Refining, Statler and Sheraton-Cadillac Hotels, Detroit.
9–13	**American Society for Metals,** Southwestern Metal Congress and Exposition, Sheraton and Other Hotels, Dallas.
23–26	**Design Engineering Show,** New York Coliseum.
June	
5–10	**SAE,** Summer Meetings, Edgewater Beach Hotel, Chicago.
19–22	**AIChE,** Meeting, Del Prado Hotel, Mexico City.
26-Jul 1	**ASTM,** Annual Meeting and Apparatus Exhibit, Chalfonte-Haddon Hall, Atlantic City.
Sept.	
14–16	**National Petroleum Association,** Annual Meeting, Hotel Traymore, Atlantic City.
25–28	**AIChE** Meeting, Mayo Hotel, Tulsa.
25–28	**American Institute of Electrical Engineers,** Electrical Conference of the Petroleum Industry, Hotel Skirvin, Oklahoma City.
Oct.	
11–14	**NACE,** Northeast Region Conference, Prichard Hotel, Huntington, W. Va.
25–28	**NACE,** South Central Region Conference, Mayo Hotel, Tulsa.
Nov.	
16–20	**NACE,** General Florida Conference and Corrosion Short Course, Key Biscayne Hotel, Miami.
Dec.	
4– 7	**AIChE** Meeting, Hotel Statler, Washington.
7–11	**NACE,** University of Illinois Corrosion Control Short Course, Urbana Campus.

Be sure to read about the newest and most efficient equipment for your plant in "New Equipment and Literature," page 238. Then, to get more complete information, circle the Readers Service Card "E" number (page 257) of the item you're interested in and mail.

STOP!

No Lubrication Ever

with Stockham's new Wedgeplug* "O-SEAL" VALVE!

It never leaks!

Why is Stockham's new Wedgeplug "O-Seal" valve the hottest thing in the industry? Because it solves your leakage and lubrication problems—for good! It's non-lubricated!!

Here's how the "O-Seal" works—

Two Teflon** "O" rings, inserted in dovetail grooves machined on the face of the plug, seat on the raised body seats when the plug is in closed position. The sealing effect of these rings gives absolute shut-off in all cases—shut-off that **remains permanently "bubble-tight."**

Hundreds of tests of this new valve in all types of services have failed to make it leak. And it never needs lubrication!

RECOMMENDED USAGES . . .

Stockham's new "O-Seal" is recommended for all general services—air, gas, water, steam, propane, hydrocarbons, etc., as well as for hard-to-hold services. Recommended for temperatures from minus 300 F to 400 F and not exceeding 720 psi. • Available in carbon and alloy steels, 2" to 12" sizes, 150 and 300 lb. pressures. Three port openings—40%, 70%, full round. Wrench, handwheel, gear, and motor operated.

Stockham makes a **BETTER** valve . . . for **EVERY** job!

OTHER ADVANTAGES

Provides Double-Block and Bleed in most services • Ends costly maintenance • Double seating for double safety. Ground metal-to-metal seat provides shut-off in case fire burns out "O" rings • Ends product contamination • Protected seats • Quick, easy operation—won't stick or bind.

*Patented **Teflon, Dupont Trademark

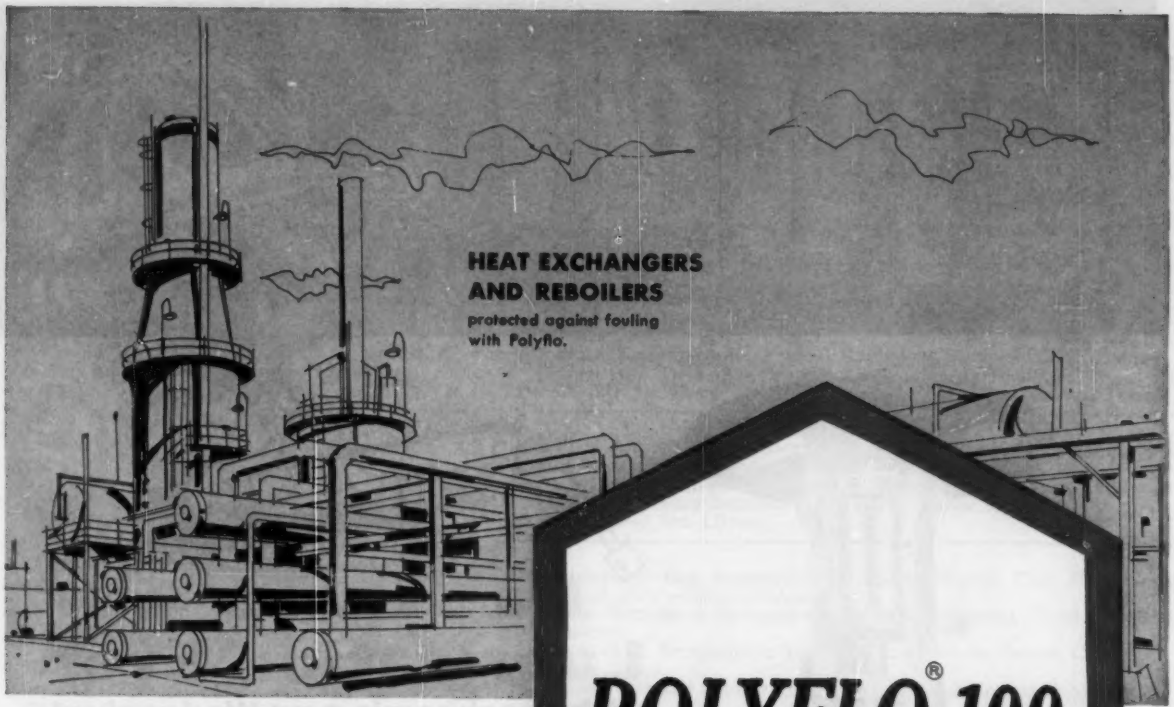
STOCKHAM'S NEW WEDGEPLUG "O-SEAL" VALVE

Call Your STOCKHAM Distributor or Sales Representative for complete details, or write today for the new brochure on the Wedgeplug "O-Seal."

WEDGEPLUG VALVE COMPANY
DIVISION OF
STOCKHAM VALVES and FITTINGS
General Offices and Plant
4003 North 10th Avenue Birmingham 2, Alabama

STOCKHAM VALVES *and* FITTINGS

CAST IRON-MALLEABLE AND DUCTILE IRON PIPE FITTINGS • BRONZE, CAST IRON, DUCTILE IRON, CAST AND FORGED STEEL VALVES



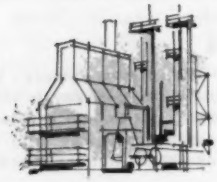
NOW... POLYFLO® 100

1 Multi-purpose Inhibitor-dispersant solves 5 pressing problems

A highly convenient all-around inhibitor-dispersant, UOP Polyflo 100 is also an effective stabilizer against thermal changes, color deterioration, sludge and deposit formation.

An effective dispersant for distillate, residual and crude oils, Polyflo 100 also eliminates fouling and sludge formation in heat exchangers and storage tanks.

Polyflo is but one of a variety of inhibitors and additives developed by UOP for petroleum refiners. Write our Products Department for detailed information on these products. Ask also about the services of our staff of treating field engineers, who will gladly work with you to solve specific problems.



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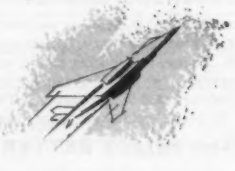

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Men In Industry...

CNGA Awards Presented at Fall Meeting

Five members of the California Natural Gasoline Association received awards for their contributions to the association's technical work and the natural gasoline industry. These awards were presented by **Warren H. Kraft,** vice president, Honolulu Oil Corp., and CNGA Awards Committee chairman, at the annual awards luncheon held during the annual fall meeting. An award for meritorious achievement, annually given to the outstanding young man in the natural gasoline industry, was presented to **D. R. Arnold,** Signal Oil & Gas Co. Arnold has been a member of CNGA since 1948 and has been very active in association affairs. He was elected to the CNGA board of directors this year.

Recipients of the Service Award of Merit were **James E. Adams,** Signal Oil & Gas Co.; **R. A. Montague,** Standard Oil Co. of California; **W. W. Warneke,** Chanslor Western Oil & Development Co.; and **R. D. Woods,** Honolulu Oil Corp.

D. R. Arnold (L) receives award from Warren H. Kraft.

L to R: W. W. Warneke, Chanslor Western Oil & Development Co.; W. H. Kraft, CNGA past president and Awards Committee chairman; R. D. Woods, Honolulu Oil Corp.; R. A. Montague, Standard Oil Co. of Calif.; K. C. Vaughan, CNGA president; and J. E. Adams, Signal Oil & Gas Co.

REFINER Authors Win Publications Award

PETROLEUM REFINER authors **John Hodson** and **C. J. Huang** have received the "Best Applied Publications Award" given annually by AIChE's South Texas Section. The winning article was "Perforated Plates Designed This Way," from the February 1958 issue. Both authors received plaques at the annual technical meeting of the section in Galveston, Texas, October 30. This is the second successive year that REFINER has shared the award.

Hodson

Huang

F. M. Files has been named coordinator of manufacturing for Phillips Petroleum Co.'s International Department. He will locate at Bartlesville, Okla., and will coordinate operations that include natural gas liquids plants and refineries in British Columbia, Canada, and San Roque, Venezuela. Files graduated from Austin College with a B.S. degree in chemistry and joined Phillips in 1930. Most of his service has been in the Refining Department. For several months prior to his promotion he had been on loan from that department to serve as technical advisor to the manager of the International Department.

J. R. MacGregor has been named a vice president and director of California Research Corp. He will be in charge of petroleum products research, succeeding **J. L. Cooley,** who has retired. A graduate of the University of California in mechanical engineering, MacGregor joined the company's Research and Development Department at Richmond, Calif., in 1925, working primarily with the development and evaluation of automotive and industrial fuels. When the company's research subsidiary was organized in 1944, he transferred there as an expert in fuels and lubricants.

Leslie D. Burritt has been appointed director of the Construction Engineering Division of Esso Research & Engineering Co., succeeding **Allen J. Ely,** who has retired. Burritt joined Esso Engineering in 1923, a year after he graduated from Stevens Institute of Technology with a degree in mechanical engineering. Initial assignments with Esso Engineering involved inspection work, including the fabrication of vessels and other equipment for the original tube and tank cracking coils. He later became a specialist in piping materials. Company assignments have taken Burritt to Japan, Europe and South Africa. In addition, he was in Venezuela from 1946-48 as resident engineer during construction of the Amuay Bay refinery of Creole Petroleum Corp.

William Oppel, Jr., has been named manager of industrial relations for Mid-Valley, Inc., succeeding **E. D. Hoeskstra,** who has joined National Constructors Association, New York. Oppel will have charge of Mid-Valley's labor relations and public relations program. He came to Houston in 1955 as project manager for Chemical Construction Corp. In 1958 he was assigned to a project at Hamilton, Ont., and was later transferred to another construction job at Fresno, Calif., returning to Houston early this fall.

Robert W. Gerhard, director of the Distribution Economics Coordination Division, Supply and Transportation Department, Standard Oil Co. (Indiana),

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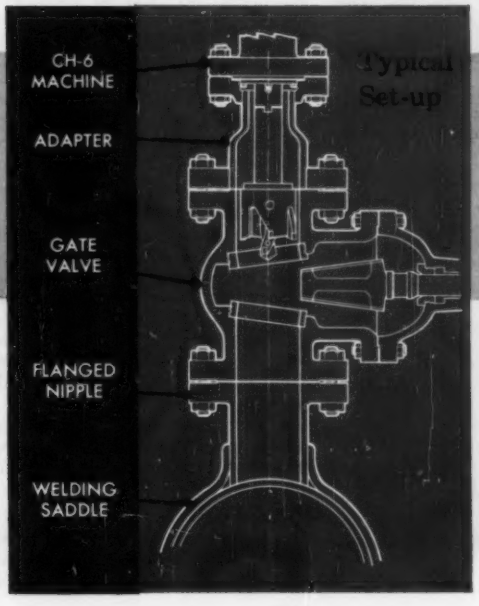

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Men . . .

has been appointed director of economic research of Societe Civile Amoco, the foreign market study group in Paris, France, for Standard. Gerhard will continue studies connected with the company's activities abroad initiated some time ago by **John W. Boatwright,** chief economist for Standard Oil since 1956. Boatwright, who has been on active assignment to Societe Civile Amoco for the past year, will retire January 1, 1960. Gerhard started with Standard Oil in 1944 as a chemical engineer at its Wood River, Ill., refinery where he advanced to Research Department group leader and later became head of the Catalytic Cracking Department. In 1953 he was named supervisor of the Cost Control Section in the General Office Manufacturing Department, Chicago. He has been director of the Distribution Economics Coordination Division, Supply and Transportation Department since 1955.

George F. Skopec has completed 50 years with Standard Oil Co. (Indiana). On February 6, 1960, his 65th birthday, he will retire. In 1909, Skopec, then 14 years old, heard of an opening at the Standard Oil Co. for an office boy. He applied for the job and was hired to work in the Chicago Sales Department. From 1910 to the time of his Army enlistment in World War I, Skopec served in clerical capacities in the Chicago Sales Department. After return from military service in 1919, he transferred to the Petroleum Products Purchasing Department, and later to the General Purchasing Department, where he served 20 years as secretary to the vice president and director of purchases. In 1937 he was transferred to the Tires-Batteries-Accessories Department, where he is presently a sales analyst.

Edwin J. Hoffman has been named supervisor of Tidewater Oil Co.'s crude processing area, Delaware refinery. **William J. Doyle** has been named unit technical foreman of the alkylation-polymerization area; **George M. Rose,** unit technical foreman of the cracking area; **Laurance A. Gleason,** unit technical foreman of the utilities and sulfur recovery area; **Charles W. McCloud,** unit technical foreman of the coking area, and **Clarence E. Slater,** senior engineer in the Engineering Department.

Dr. Richard L. Rowton has been appointed to Jefferson Chemical Co.'s Austin Laboratory research staff along with **A. A. Szemborski, Dr. Walter H. Brader, Jr.,** and **Miss Elaine Peters.** Dr. Rowton has B.S. and M.S. degrees in chemistry from the Missouri School of Mines, and a Ph.D. degree in chemistry from Oklahoma State University. He spent two years in the Army at Fort MacArthur as chief petroleum laboratory technician. Szemborski joined Jefferson Chemical after a tour of duty in the Army Chemical Corps at Fort McClellan. He is a graduate of the University of Michigan with B.S. and M.S. degrees in chemical

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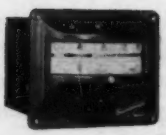

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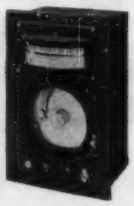

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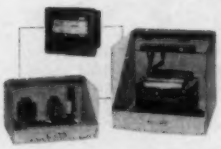

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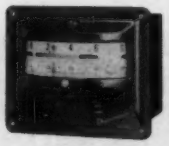

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Men . . .

engineering. Dr. Brader received an A.B. degree in chemistry from Rice Institute, and Ph.D. degree from Georgia Institute of Technology. Before joining the staff at the Jefferson Research Laboratories, he was project chemist at the laboratories of Standard Oil Co. (Indiana), Whiting, Ind. Miss Peters joined Jefferson Chemical Company's Research Laboratories after working as a research chemist with Columbia Southern Chemical Corporation.

Lawrence C. Brunstrum, section leader in lubricants research, Whiting Research Laboratories, Standard Oil Co. (Indiana), has been selected chairman of the General Technical Committee, National Lubricating Grease Institute. He will direct activities of several subcommittees in such fields as basic research, testing, and manufacturing. Brunstrum joined Standard in 1929, after graduating in chemical engineering from Armour Institute of Technology. He has directed both basic and applied studies of greases and other lubricants, and is active in several scientific and technical societies, including ACS, American Association for the Advancement of Science, and ASLE.

Macauley Whiting has been appointed general manager of Dow's Midland Division, succeeding the late **Dr. William H. Schuette,** who died unexpectedly November 8. Whiting has been manager of Service Departments for the Midland Division since 1956, and as such has been responsible for engineering and construction, maintenance and plant services, utilities, purchasing, standards, traffic, and miscellaneous services. He began with the company as a student trainee in 1948, and spent a year as an engineer in the Mechanical Development Department, and two years with the Production Economics Department. In 1952 he became a results engineer in the Power Department, and was named manager of that department a year later. He has been a member of the Midland Operating Board since 1954.

Dr. David S. Weddell of Geneva, Switzerland, European technical representative for Monsanto Chemical Co.'s Research & Engineering Division, will become assistant director of development for the company's Overseas Division, St. Louis, on January 1, 1960. **Dr. Charles H. Davenport,** El Dorado, Ark., assistant director of research for Monsanto's Lion Oil Co. Division, will replace Weddell at Geneva. **W. D. Hill,** who has been with Weddell in the Geneva office since 1957, will continue to share liaison responsibilities with Davenport. Weddell joined the Research Department of Monsanto's former Phosphate Division in 1941, after receiving his Sc.D. degree in chemical engineering from Massachusetts Institute of Technology. He is a former assistant director of development of the Research & Engineering Division and has held several other Mon-

santo research and development posts. He was transferred to Geneva in his present capacity in 1954. Davenport received his Ph.D. degree in chemical engineering from Massachusetts Institute of Technology. He joined Lion Oil Co. in 1948 as senior group leader in the Engineering Research and Process Development Group after serving in various research capacities with Standard Oil Development Co. and Swift & Co. He was promoted to his present position with Lion in 1955.

Burns

Buzzi

A. A. Buzzi has been named financial vice president of Shell Oil Co., succeeding **A. G. Schei,** who will retire December 31. Buzzi will be succeeded as controller by **R. K. Burns,** who is assistant controller and assistant treasurer of Shell Chemical Corp. **H. W. Egliht,** special assistant to the controller, will succeed Burns. Buzzi joined Shell in 1923 as a timekeeper at the Arkansas City, Kan., refinery, while Schei started his career in 1924 as a clerk in the company's Seattle office.

Burns joined Shell in 1930 as an office boy at the company's Wood River, Ill., refinery, and Egliht joined the company in 1924 as a clerk in the company's San Francisco office.

Peter F. Quinn has been named treasury manager, Synthetic Rubber Division, Shell Chemical Corp., Torrance, Calif. He joined Shell Chemical in July 1947 as a clerk in the Eastern Marketing Division, New York. He later became supervisor of stock accounting in San Francisco and was transferred to Houston in 1950 as supervisor of utility accounting. Quinn transferred to head office general accounting as a senior accountant in April 1953. In 1954, he became chief accountant at Houston and two years later was made treasury manager of the Agricultural Chemical Sales Division, New York. Prior to taking the Torrance assignment, he was assistant manager, financial accounting, at Shell Chemical Corp.'s head office Treasury Department, New York, a position he had held since February 1958.

R. T. Cox, manager of The Atlantic Refining Co.'s Rocky Mountain Region, will succeed **Niles B. Winter** as manager of the West Texas-New Mexico Region when the latter retires in May 1960. **A. B. Macaulay,** manager of the company's Oklahoma-Kansas Region, will succeed Cox at that time.

Winter has served the company in West Texas since 1927 when he went to Pecos as resident geologist. Cox has

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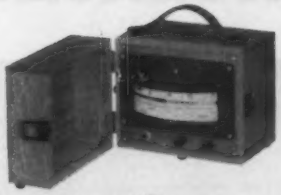

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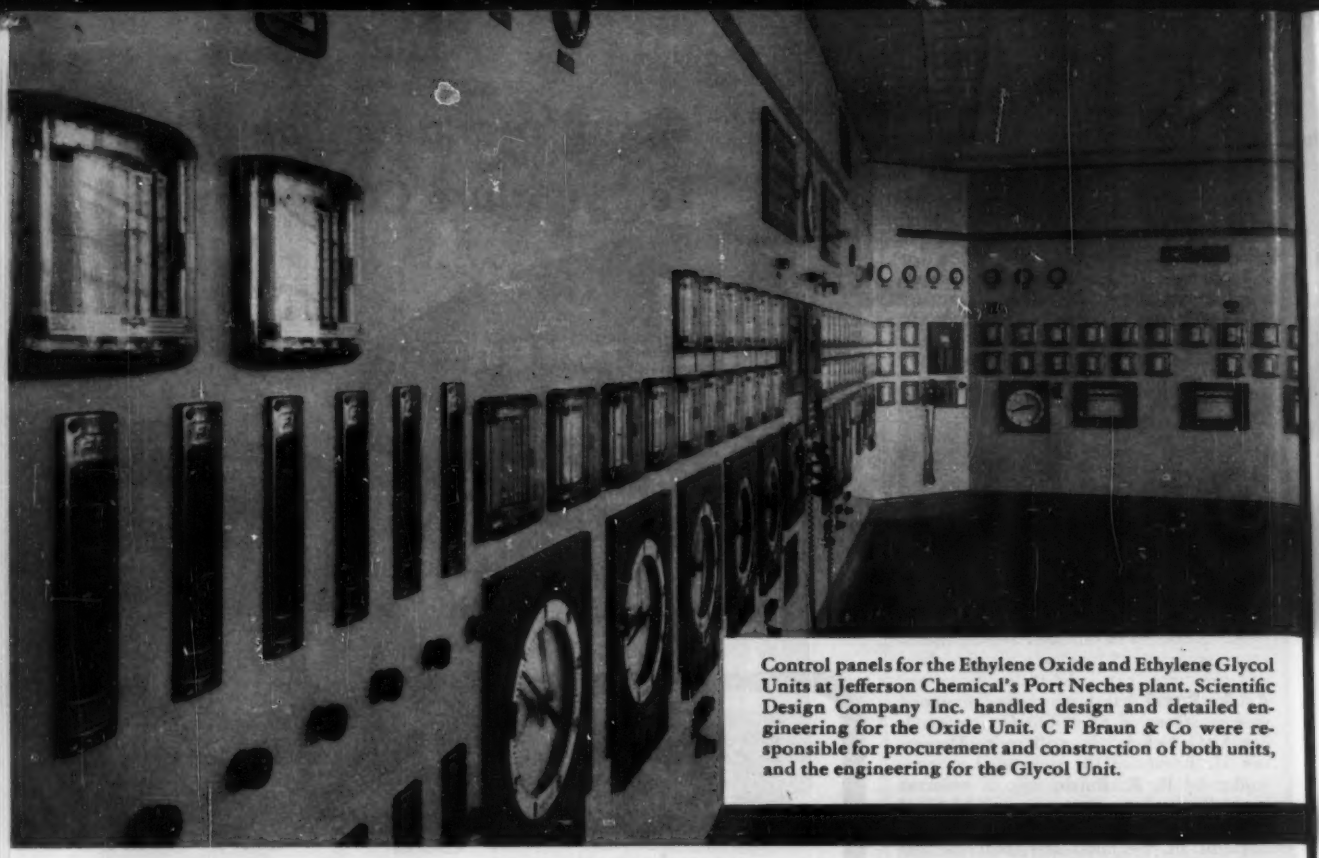
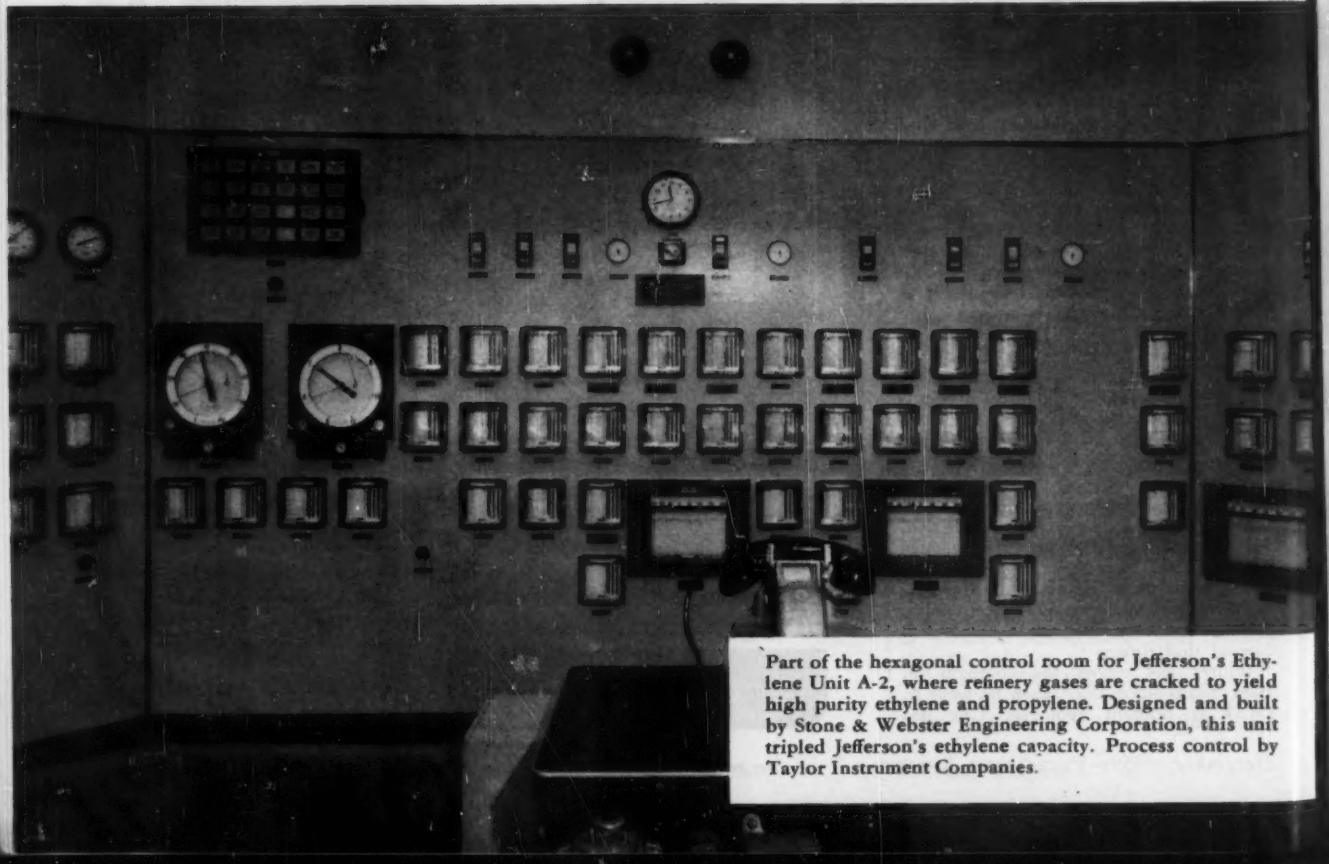


Control panels for the Ethylene Oxide and Ethylene Glycol Units at Jefferson Chemical's Port Neches plant. Scientific Design Company Inc. handled design and detailed engineering for the Oxide Unit. C F Braun & Co were responsible for procurement and construction of both units, and the engineering for the Glycol Unit.

JEFFERSON CHEMICAL RE-ORDERED TAY



Part of the hexagonal control room for Jefferson's Ethylene Unit A-2, where refinery gases are cracked to yield high purity ethylene and propylene. Designed and built by Stone & Webster Engineering Corporation, this unit tripled Jefferson's ethylene capacity. Process control by Taylor Instrument Companies.

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The statements above, and many other equally complimentary comments, were made by the Instrument Engineer at Jefferson Chemical Co., Inc., Mr. J. W. Rutledge. He's referring to the performance of TRANSCOPE instrumentation at the Port Neches plant, first on the Ethylene Unit A-2 and later on the Ethylene Oxide and Ethylene Glycol Units.

In Mr. Rutledge's own words: "The new Taylor TRANSCOPE instruments were purchased for subsequent expansion, due to the fine performance of these instruments on our previous unit start-ups and the smooth operation of the operating units, as well as the low initial cost".

The photographs at left show a few of the several hundred TRANSCOPE Plug-in Recorders in use at Port Neches. In addition, Jefferson Chemical use many TRANSCOPE Indicators and Controllers and TRANSAIRE* Temperature Transmitters.

"Never before so many features in so little panel space", has been our claim for the 90J Transcope Recorder since first introduced. The experience of Jefferson Chemical, and of many other companies in the chemical, petroleum and petro-chemical field all over the world is, we believe, eloquent "proof of the pudding".

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Men . . .

been manager of the company's Rocky Mountain Region since 1954, and has been with Atlantic since 1933.

Macaulay has been with Atlantic since 1934 and has served in the Accounting Department as manager of the Administrative Division, and as assistant to the vice president of foreign and domestic production. He has been manager of the Oklahoma-Kansas Region since June 1958.

Angus R. S. Leitch has joined the engineering firm of Barry and Richardson, Calgary, Alb., office. He holds a M.S. degree in chemical engineering from the University of Alberta.

Leitch

After graduation Leitch was technical assistant for the production of ethylene from natural gas for Canadian Industries, Ltd., Edmonston. He also has been a production engineer with Canadian Gulf Oil Co., Calgary, in the Gas and Gasoline Department. He later was a process engineer, working on petroleum, petrochemical and natural gas processes, for C F Braun and Co. Leitch also has worked with the Ralph M. Parsons Co., Los Angeles, and Brown and Root, Ltd., Calgary, as a process engineer.

Robert B. Woodin has been named director of financial and public relations for Delhi-Taylor Oil Corp., Dallas. He will supervise the preparation of all reports to stockholders, handle press relations, and assist in the preparation of budget and financial reports and analyses. Woodin holds a M.S. degree in business administration from Southern Methodist University. Prior to joining Delhi-Taylor, he was supervisor of the Valuation Section, Valuation and Budget Division for a major oil company in Dallas.

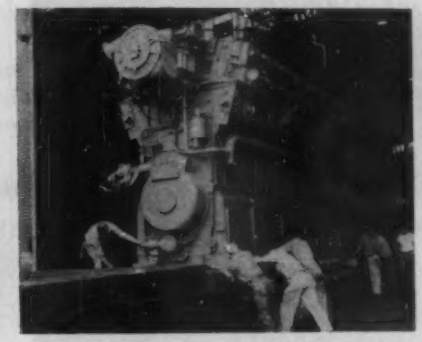
Arnold D. Bennison has completed 40 years of service with General Petroleum Corp. He has been director of oil supply since 1953. He joined the company as a laborer at Vernon in 1919. In 1929 he became a member of the home office sales staff, in 1934 manager of bulk oil sales and in 1938, manager of fuel oil sales. He became manager of the Oil Supply and Exchange Department in 1942, a position he held until he was elected director.

Dr. Charles F. Jelinek has been appointed manager of new fields research at the Easton, Pa., Central Research Laboratories of General Aniline & Film Corp. He replaces **Dr. Joseph M. Wilkinson, Jr.,** who was recently promoted to director of development of the Corporate Development Department. Dr. Jelinek had previously been manager of the Process Research and Development Department at the Rensselaer, N. Y., plant of the Dyestuff & Chemical Divi-

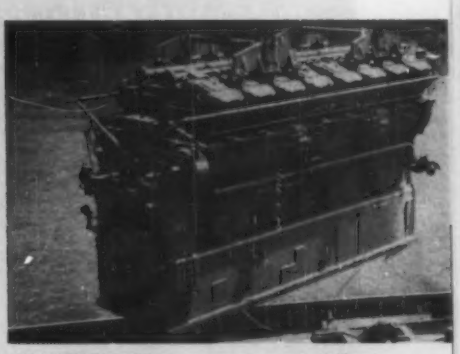
Landing Craft Cuts Construction Costs

Kellogg's Procurement Division Avoids Dismantling, Crating, Reassembling in Shipping Huge Diesel Engines to Mobil Oil Company de Venezuela Refinery

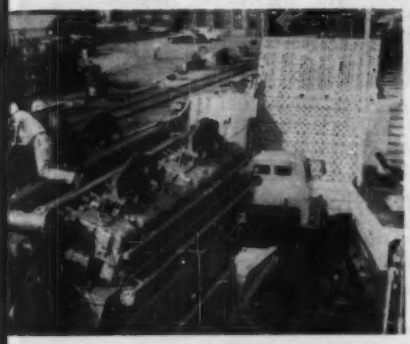
ASSIGNMENT: A 50,000 BPD refinery, complete with diesel electric power plant, being built by Kellogg for Mobil Oil Company de Venezuela at El Palito—100 miles west of Caracas, on the Caribbean.



PROBLEM: Minimize man-hours for delivering and installing four of these 100-ton diesel engines, required for the power plant, by avoiding the dismantling, crating, and reassembling usually needed.



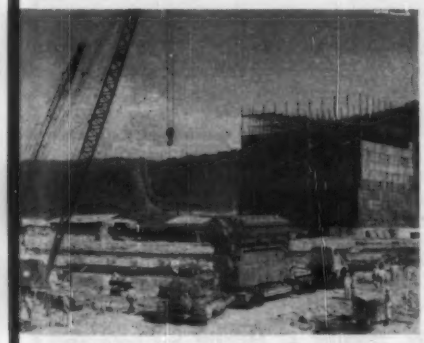
SOLUTION: Have engines sent, fully assembled, by rail to Newport News, Va.—most economic shipping point from vendor's plant, and there hoist them to deck of a commercial landing craft.



LOADING: Also on deck—loaded last so it could go ashore first—is a heavy-duty truck and lowboy, onto which one of the diesel engines has been lowered in readiness for landing near the refinery.

LANDING: Ready to move as the craft reaches El Palito, the first engine goes right up on shore—its landing facilitated by an earthern dock, quickly constructed by the refinery's bulldozer.

HAULING: With less than 1000 yards to go from landing place to refinery site, truck and lowboy make the first of four trips to complete the 400-ton shipment of diesel engines for the power plant.



APPROACHING: With assistance from the bulldozer, one of the huge diesels slowly approaches its destination—where foundations have been made ready to allow immediate installation of all four.

POSITIONING: Skids, hawsers, and hoists help to place one of the four engines in position on its concrete foundation, as skilled hands get ready to securely bolt the first unit of the power plant.

INSTALLED: Another example of Kellogg's ability to procure, deliver, and install refinery equipment at minimum cost, diesels are installed in Venezuela just ten days after leaving Virginia.

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The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., Buenos Aires • Societe Kellogg, Paris
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M KELLOGG W

ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling

Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ... Tube Expanders ... and Related Accessories

Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

Other related accessories include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.

Write for descriptive literature *today*.

Y8-2

ELLIOTT Company
LAGONDA PLANT, Springfield, Ohio

Men ...

sion. He joined General Aniline in 1946 and has served as research chemist, applications research manager and sales engineer for the Dyestuff & Chemical Division.

Dr. Heinz Schulze has been appointed to the research staff of Jefferson Chemical Co.'s Austin Laboratories. He was previously with the Applied Science Research Laboratory of the University of Cincinnati where he was an associate professor. Dr. Schulze has a Ph.D. degree from the University of Goettingen, and has been with I. G. Farbenindustrie, A. G., and Bayer, Leverkusen, Germany. He then spent two years in Switzerland, after which he became head of the Organic Chemical Branch of the Institute of Soil Biochemistry at the Research Institute for Agriculture, Braunschweig, Germany. A leave of absence from the Institute allowed him to work with the Signal Corps of the U. S. Army at Fort Monmouth, N. J. Dr. Schulze then joined the Ansco Division of General Aniline & Film Corp., Binghamton, N. Y., where he worked for several years before joining the University of Cincinnati.

Schulze

E. H. Tollefson, president of the Consolidated Natural Gas Co., has been re-elected chairman of the board of trustees of the Institute of Gas Technology, an affiliate of Illinois Institute of Technology. Three new trustees were elected and seven trustees re-named during the recent IGT annual meeting. Elected to fill vacancies on the board were **Ed Parkes,** president, United Gas Corp., Shreveport, La.; **R. F. Brooker,** president, Whirlpool Corp., St. Joseph, Mich., and **Karl E. Schmidt,** vice president, Michigan Consolidated Gas Co., Detroit Mich.

Dr. Scott W. Walker, assistant manager of research for Pan American Petroleum Corp., and for six years a faculty member at Massachusetts Institute of Technology, has been named dean of the College of Petroleum Sciences and Engineering at the University of Tulsa. He will join the staff February 1 and take over his new duties June 1.

The new dean replaces **Harry N. Carter,** who has been acting dean since **R. L. Langenheim** retired last spring. Langenheim had served as dean since 1929.

Dr. Homer Z. Martin has been appointed coordinator of petroleum process research in Esso Research & Engineering Co. With the company since 1937, his research mainly has been on catalytic cracking. He also has done research on synthetic fuels and other process developments. Until his new appointment, Dr. Martin was special assistant in the office of the coordinator of fuels processes.

For more data on advertised products, use Readers' Service Cards, last page.

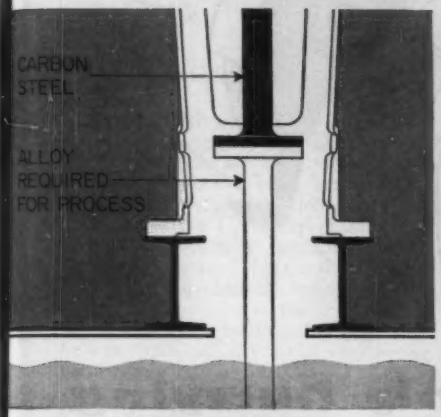
If you want to cut fluid mixing costs
look inside the tank

You can make some of your biggest cost reductions *inside* the tank, when you select a mechanical mixer for fluids.

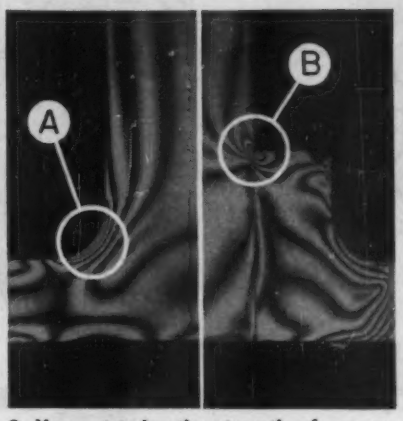
These are *long-term* savings—based on low-cost maintenance, trouble-free service, adaptability to changes in your process, minimum spare-part requirements.

These are the areas where you can *really* save money on fluid mixing. And here are some in-the-tank reasons why you can do it better with LIGHTNIN Mixers than with any other make. For lowest-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Refinery Catalog. Or write us direct.

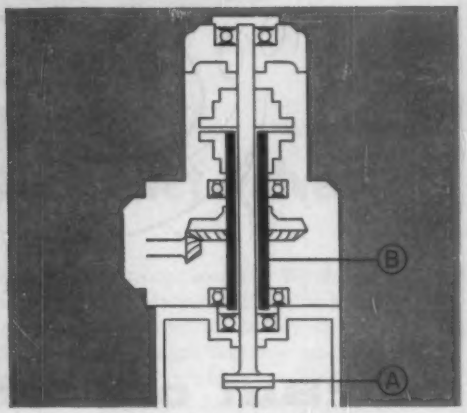
Save 6 ways with these *Lightnin* shaft and impeller refinements



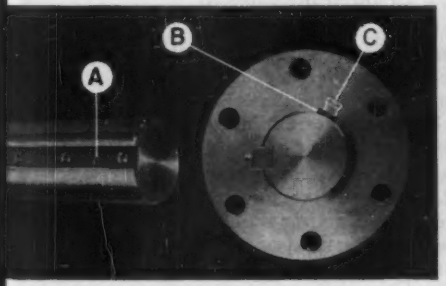
1. Get lower-cost installation, upkeep with two-piece shaft. Standard on open-tank units (available with closed-tank units, too), lower section is alloy required for process; upper section can be inexpensive carbon steel. Rigid coupling has rabbeted joint assuring accurate alignment.



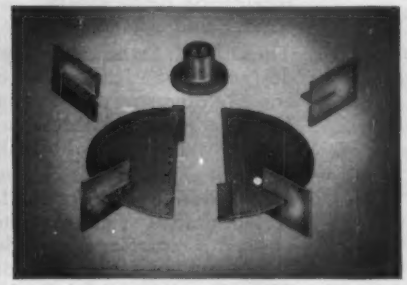
2. You get twice the strength of conventional shaft couplings with LIGHTNIN deep-welded coupling (A). Not one of these couplings has ever failed in service. Polarized light shows how machined and polished radius eliminates stress concentration found in conventional coupling (B).



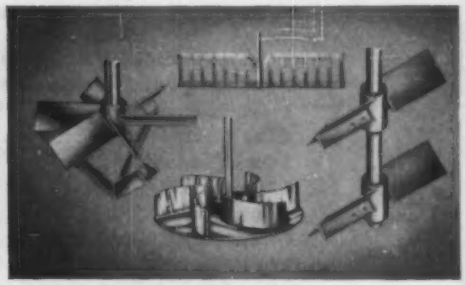
3. No need to disturb gearing if you ever want to replace a LIGHTNIN shaft. Lower shaft is unbolted at (A). Upper shaft slides out of hollow reducer quill* (B). Gears remain untouched—cannot get out of line. When new shaft is installed, shaft alignment is automatic. *Patented



4. Save time positioning impellers. Standard 18-inch shaft keyway (A) provides seven positions (more if you want)—saves you cost of special machining. Also note shallow extra keyway (B) for impeller hub setscrew (C). It permits impeller to slide freely, even if shaft is burred.



5. Cut impeller replacement cost with LIGHTNIN all-bolted design. Replace blades without buying a whole new impeller. Blades come off to pass small openings; or impeller can be supplied split, as shown. Same disc takes 4, 5, 6, or 8 blades for easy change in power input.



6. Get the right impeller for your needs. You can handle practically any fluid mixing requirement with a standard LIGHTNIN impeller. But for special jobs, you can get LIGHTNIN impellers made to specification in all machinable materials and with widest choice of coverings.

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ¼ to 3 HP (B-108)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 164-n Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® Mixers™

MIXCO fluid mixing specialists

"But officer, we were only hurrying to pick up his P.F.I. STANDARDS!"

SEND COUPON BELOW FOR THESE P.F.I. STANDARDS

1 Machining Backing Rings for Butt Welds
2 Dimensioning Welded Assemblies
3 Linear Tolerances Bending Radii
4 Shop Hydrostatic Testing
5 Cleaning Fabricated Piping
6 Built-up Weld, Metal Bosses
7 Welded Nozzles—Spacing
8 Preheat-Postheat Before, After Welding
9 Arc-Welding Dissimilar Ferritic Steels
10 Stress Relieving Practices

The traffic officer could be more sympathetic, but he's heard all kinds of "fabrications" . . . unfortunately, he doesn't understand the many problems of pipe fabrication or he would know all about the value of P.F.I. Standards.

These P.F.I. Standards are packed with vital data on the design, the fabrication and erection of high pressure and high temperature piping used by all industry. However, these technical bulletins do not explain the many advantages of shop fabrication.

Remember, shop fabrication by the companies responsible for the development of P.F.I. Standards is your only real assurance of meeting the most exacting requirements of piping, whether it's welded, bent, coiled or vanstoned . . . in any metal as a component or a complete assembly. Write for all ten P.F.I. Standards or indicate in the coupon below which ones could be helpful to you.

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Devoted to the Technical and Economic Problems in Piping

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For more data on advertised products, use Readers' Service Cards, last page.

Men . . .

Before that he was director of the Process Research Division. He has M.A. and Ph.D. degrees in chemical engineering from the University of Michigan, and a B.S. degree in chemical engineering from Illinois Institute of Technology.

Frederick C. Westphal, Jr., became manager of Esso Standard Oil Co.'s Bayonne, N. J., refinery on December 1. He has been administrative superintendent of Esso's Bayway refinery, Linden, N. J., for the last year. As manager at Bayonne, Westphal succeeds **David F. Edwards,** who has joined the new Humble Oil & Refining Co., as employe relations manager. Westphal joined Esso in 1940.

—Deaths—

Lester J. Richards, 66, retired director of engineering for The Dow Chemical Co., died at his home in Midland, Mich., November 2 of a heart attack. He joined Dow in 1917 following graduation from the University of Michigan with a B.S. degree in mechanical engineering. He served successively as a draftsman and chief draftsman and became chief engineer at the Midland operations in 1934, holding that post until he was appointed director of engineering for the company in 1950.

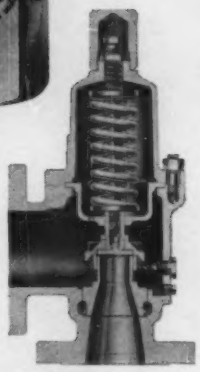
K. A. Beede, general superintendent of plants in the New York Region for American Oil Co., died October 23 after a brief illness. Prior to his appointment as general superintendent of plants, Beede was superintendent of Amoco's Rensselaer, N. Y., terminal. He joined Amoco in 1926.

William R. Boyd, Jr., 74, former president of API and a nationally-known oil industry leader for three decades, died November 6 in Teague, Texas. He received the Medal of Merit, the nation's highest civilian decoration in 1946, for his work as chairman of the Petroleum Industry Council for National Defense in World War II. He retired from the presidency of API in 1949. In addition to his oil industry activities, Boyd won recognition in local and national government. He joined the API staff in 1920, just a year after formation of the association, as assistant general secretary and counsel. He was elected executive vice president in 1929 and president in 1941.

Dr. William H. Schuette, 47, a vice president of The Dow Chemical Co. and general manager of its Midland Division, died of a heart attack at the Midland, Mich. Hospital November 8. Midland Division general manager since 1955, he was elected a director of the company in 1957 and a vice president last year. Dr. Schuette started his Dow career in the chemical engineering laboratory at Midland in 1941. From 1952-55 he was manager of plastics production.

in process safety-relief valves

From the Near East to our own Far West . . . the name Farris on safety-relief valves has been a standard synonym for safety since 1943. The patented design features on all Farris full-nozzle valves combine to offer the ideal concept of a trouble-free, 100% safe safety-relief valve for every application.



SERIES 2600

The most popular top-guided, self-aligning, safety-relief valve for process piping service. Maximum pressure, 150 to 2500 psig, RF/RJ. Plain or Lever types. Standard or BalanSeal bellows construction.

SERIES 2740

A cast-steel relief valve of simplified design for use where extreme blow down accuracy is not essential, but where durability, compactness are. Pressures to 3500 psig at 450°F; 2000 psig at 800°F. Sizes ½" to 2".

SERIES 2745

An extremely rugged, compact, high pressure bar stock nozzle valve. Internal parts stainless steel. Adjustable blow down; flat seat; self-aligning stem and disc. Pressure to 10,000 psig. Sizes ½", ¾", 1".

SERIES 2950

A cast iron safety-relief valve including most of the exclusive Farris features found in the Series 2600. Max. pressure, 250 psig at 450°F, 400 psig at 150°F. Plain cap, open lever or packed lever types.

Complete information is provided in Catalog FE-118, covering both selection and sizing of Farris process Safety-Relief Valves. Send for your copy today.

PROGRESS THROUGH HONEST PURPOSE — Farris

ENGINEERING CORP.

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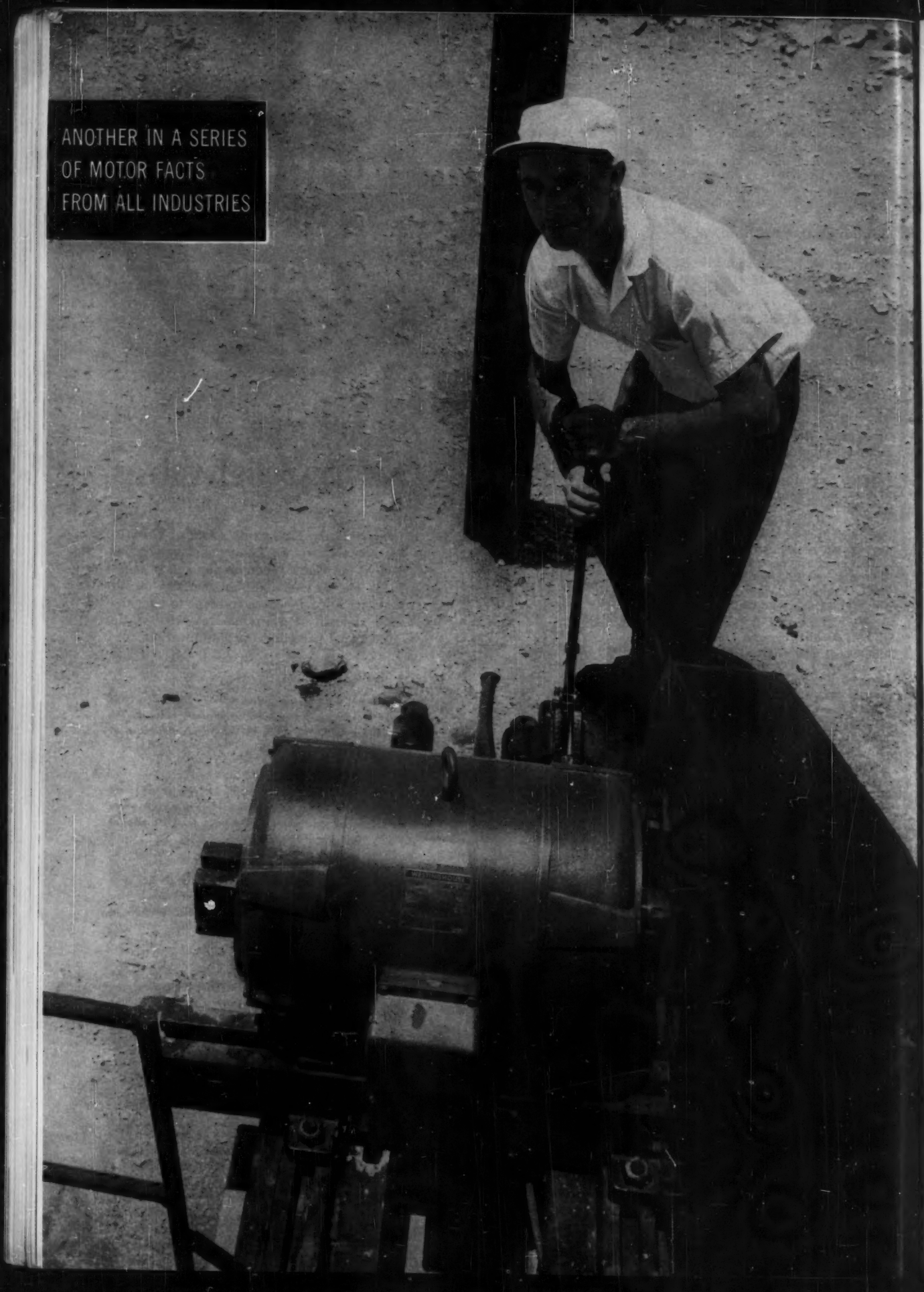

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

Sand... heavy rain... extreme heat...

Nothing stops These Westinghouse Life-Line A Motors

dependably driving oil well pumps in Odessa, Texas district of The Atlantic Refining Company, 24 hours per day, 7 days a week!

"Here's an application," says A. P. Johnston, production engineer at The Atlantic Refining Company, "where we must have continuous motor operation . . . sometimes for as long as 18 months . . . with virtually no maintenance or repair. Many of our pumping stations are remotely located, automatic and unmanned. Any stoppage or motor failure would result in the loss of several hundred barrels of oil. Motor repairs in the field are prohibitive in cost. We must have *complete* motor reliability and that's exactly what we get from our Westinghouse Life-Line® "A" motors."

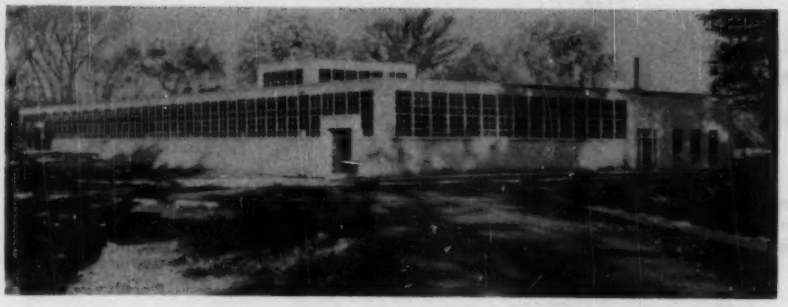
How about you? Got a really tough motor application which you can't afford to pamper? Then ask your Westinghouse sales engineer to show you how the dependable Life-Line "A" pays for itself through reduced maintenance and repair. Or write to Westinghouse Electric Corp., P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J-22055-R

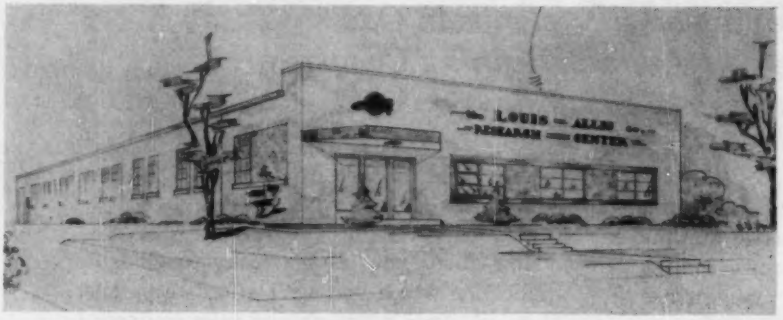
YOU CAN BE SURE...IF IT'S Westinghouse

On this pumping unit, the 15-hp Life-Line "A" motor operates in an atmosphere of damaging dust, sand and moisture. Despite continuous, heavy-duty service, motor has never suffered any overheating since first installed. Prelubricated bearings of the Life-Line "A" eliminate periodic greasing . . . keep lubricant in . . . dirt out.

Suppliers Notes...



Crane Packing Co., Morton Grove, Ill., has completed what it says is the first plant devoted exclusively to full-scale processing of Du Pont Teflon. Included in this is the processing of basic Teflon shapes (sheet, rod, tubing and tape) and the manufacture of both standard and custom proprietary items. The new Teflon plant provides complete molding and machining facilities. Total manufacturing area of the one-story building is more than 20,000 square feet plus a centrally mounted 400-square feet cupola for handling vertical extrusions.



The Louis Allis Co., Milwaukee, plans to build a new research and development center in the neighboring suburb of Greendale, Wis. The building, which will be staffed by 100 engineers and technicians, will double the size of the present engineering and physics laboratories.

CARBOLINE CO. has assigned **William A. Wood, Jr.,** to its Technical Sales Department, Houston. A graduate of Tulane University with a B.S. degree in chemical engineering, Wood has been active in the field of protective coatings design, sales and service in the Gulf Coast area for more than 10 years. He was chairman of the Houston Section of NACE in 1958 and has served on several of the association's technical committees dealing with coatings problems. He also has been on the board of directors of the Houston Coating Society.

Wood

GENESYS CORP.'S Product Development Department has appointed **John B. Gray** a project engineer for electronics. Holder of a B.S. degree in mechanical engineering from Stevens Institute of Technology, his background includes positions at Sperry Gyroscope Co., Hughes Aircraft Corp., and General Avionics Co.

AMERICAN-STANDARD INDUSTRIAL DIVISION has named **Richard J. Riedl** product manager in charge of the Heat Exchanger Products Department. He will be responsible for all phases of market planning, evaluation and development for heat exchanger products. A graduate engineer of the University of Michigan, he joined Ross Heat Exchanger Division of American-Standard in Buffalo, N. Y., in 1950. He was manager of contract engineering at the Buffalo plant before coming to Detroit in his new position.

Riedl

BROWN FINTUBE CO. has named **John W. Nevins** chief engineer. He was formerly chief draftsman, and has been with the company since 1942. He has been a laboratory technician, process engineer, project engineer, and design engineer. Nevins will be in charge of engineering on all Brown products.

DIAMOND ALKALI CO.'S Electro Chemicals Division has transferred **John H. Fonner, Jr.,** from its Muscle Shoals, Ala., plant to the Edgewood, Md., plant as assistant plant manager. **Erich G. Schlaile** moves from the Edgewood plant to the Deer Park, Texas, plant as a process engineer. **Robert S. Stark** also transfers from the Edgewood plant to the Research and Development Department, Painesville, Ohio. Fonner joined Diamond five years ago as a plant chemist at Muscle Shoals. Previously, he was with Columbia Southern Chemical Corp., Lake Charles, La. Schlaile also joined Diamond five years ago as production control supervisor at the Edgewood plant. He holds a B.S. degree in chemical engineering from the University of Maryland. Stark joined Diamond in September 1933 as a group leader at the Painesville plant. His experience has been in supervisory capacities in the electro chemicals field.

UNION CARBIDE CHEMICALS CO. has named **Lester D. Polderman** product sales manager. He will be responsible for market planning of ethylene oxide and its derivatives, and will continue his efforts on dehydration and sweetening of natural gas. After receiving a B.S. degree in chemical engineering from Newark College of Engineering in 1936, Polderman joined the chemicals company as a sales engineer. He was a senior design engineer from 1945-49 when he was promoted to supervising engineer. In 1957, Polderman was named manager, engineering services, Technical Service Department, and was assistant product sales manager from 1958 to the present time.

MIDWEST PIPING COMPANY, INC., has named **Louis H. Niebling,** former Chicago District manager, general manager of Southwest Operations, Houston. He will be in complete charge of all Midwest piping operations in the Southwest, including manufacturing, fabrication, construction and sales. Niebling has been with Midwest 31 years. **Walter J. Janesch,** previously sales representative for the Chicago area, has been appointed Chicago district manager. Janesch formerly served in the City Sales Department, St. Louis office. **N. G. Saldana,** formerly project engineer at Midwest's St. Louis office, has been transferred to the Chicago office as Chicago sales manager for fabrication and construction.

COMPUTER SYSTEMS, INC. has named **Raymond W. Carney** vice president of manufacturing. He had previously been production manager eight years. **Charles B. Husick** has been moved up from manager to vice president of engineering and systems development. Prior to his three years association with Computer Systems, Husick was applications engineer with the Data Reduction and Automation Division of Fischer and Porter Co. **Henry Zaron,** a department chief for seven years, has been named vice president of operations and facilities. He was form-

MAGIC GENIE OF THE REACTOR

HARSHAW CATALYSTS

WILL DO A *GIANT'S* WORK FOR YOU

Harshaw Catalysts do a giant's work and Harshaw produces catalysts in giant quantities—carloads every week. A letter or phone call will put our 20 years' experience and acres of production and research facilities to work for you.

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

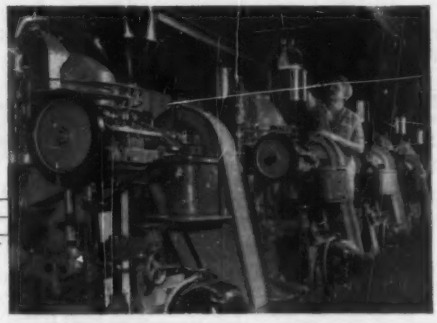
Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming — Dehydrogenation — Alkylation
Cyclization — Dehydration — Hydrogenation
Oxidation — Desulphurization — Hydro treating
Chlorination



THE HARSHAW CHEMICAL CO.

Chicago • Cincinnati • Cleveland • Detroit • Hastings-On-Hudson
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Write for FREE Book

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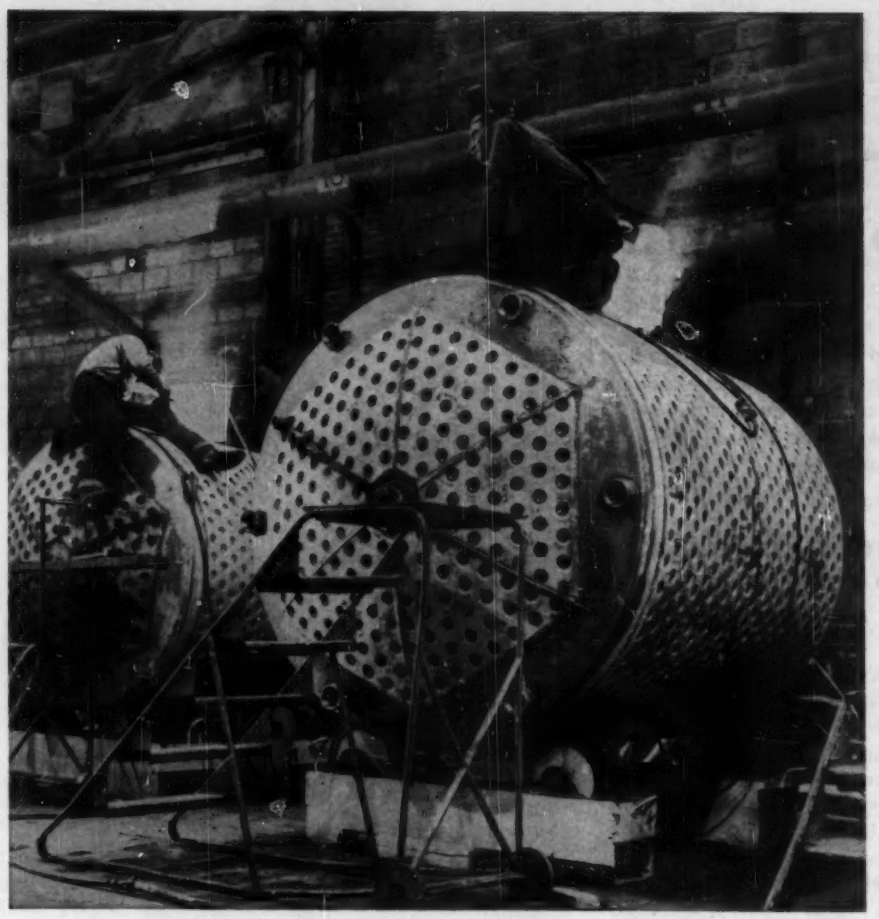
FLUIDICS* AT WORK



Operate to 600° F. with Pfaudler dimpled-jacket reactors

The stainless steel dimpled jacket on a Pfaudler stainless steel reactor is 10-gauge, reinforced by the unique "dimpled" construction. Thus it resists distortion and metal fatigue at high temperatures.

It has a permissible maximum operating temperature of 600°F.—even allows a difference of 450°F. between jacket and vessel contents.

It is code approved for 150-psi jacket pressure. You can get custom designs code approved for 175 psi.

Higher jacket turbulence. Triangular spacing of the dimples interrupts flow of jacket medium and produces maximum turbulence. Baffling further increases velocity, insures complete circulation around the vessel, eliminates hot spots and all possibility of the medium short-circuiting.

Better heat transfer. A study at the Pfaudler Test Center showed heat transfer rates to be significantly greater for dimpled jackets compared to the conventional design.

Costs are lower, too. Savings over conventional jackets are realized at about 750-gallon capacity and/or 100-lb. jacket pressure.

Dimpled jackets are an excellent example of the FLUIDICS program at work. Pfaudler pioneered their use in the process industries, tooled for them, and acquired the know-how.

Complete specifications described in Bulletin No. 944.

How to get 100% corrosion resistance in the next heat exchanger you buy

Pfaudler tantalum bayonet heaters have virtually *zero* corrosion rate in most corrosives at concentrations and temperatures normally encountered in the process industries. The exceptions are hydrofluoric and fuming sulfuric acids and alkalies above pH 8.

We won't recommend one of these heaters if we can't assure you 100% protection.

So, in your design figuring, forget about corrosion loss factors. You'll lose nothing to corrosion.

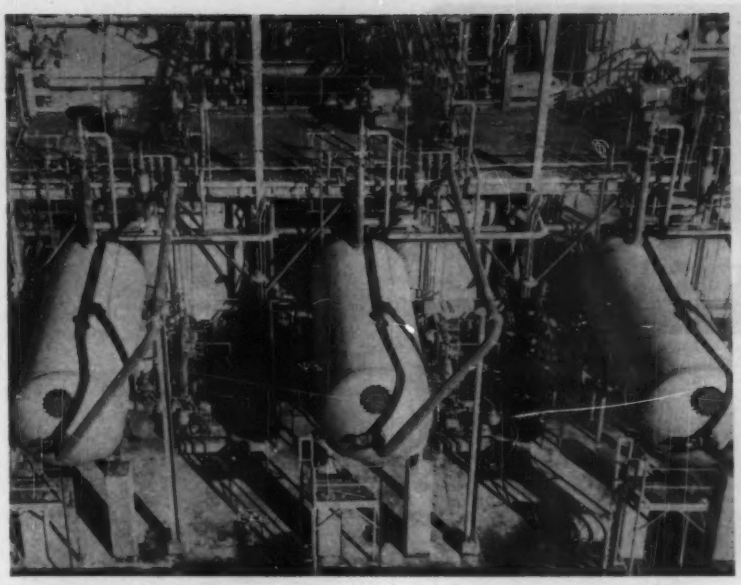
High heat transfer. Since there is no corrosion loss, we can use very thin wall sections. You get extremely high heat transfer rates with no fouling. Also excellent resistance to physical and thermal shocks.

Design: Extremely thin tantalum envelope over inner distributor tube of carbon steel, which serves as steam ejector.

Sizes: 1½" O.D. tubes in lengths to 72" in clusters up to 5 units, offering up to 12 sq. ft. of heat transfer area. Also 2" O.D. tubes in lengths to 84" in clusters up to 4 units with heat transfer areas up to 15 sq. ft. Other sizes on custom order.

New Bulletin No. 978 covers tantalum heaters plus process equipment of titanium and zirconium.

For more data on advertised products, use Readers' Service Cards, last page.



FLUIDICS FIGHTS CORROSION

How Phillips Petroleum saves on equipment for processing natural gas liquids

Phillips Petroleum at Borger, Texas, uses a highly corrosive $AlCl_3$ and HCl catalysis to process natural gas liquids.

The ability of these active chemicals to corrode nonresistant process equipment and to contaminate the product is made even stronger by the high temperature and operating pressure of the process.

Complete Glasteel protection. So wide is the Pfaudler line of process equipment, Phillips was able to select all the following from our standard line: Three Glasteel reactors. Three Glasteel horizontal tanks. Two Glasteel towers. One Glasteel recovery tank.

Problem-free operation. Products have poured out of this plant without any problem of product contamination or Glasteel equipment loss due to corrosion.

Now a second plant — Probably the best proof of Glasteel's success in the process is the fact that Phillips has now built a second plant which is also of Glasteel construction.

The complete line of Glasteel process equipment is included in the *new* Buyer's Guide.

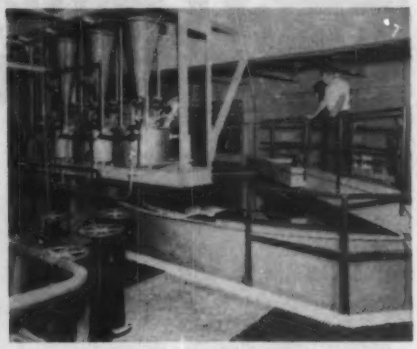
NEW FLUIDICS BUYER'S GUIDE. Get the full story on flow rate control, reactions, heat transfer, fluid analysis, corrosioneering, etc., plus the many products and services offered by the FLUIDICS program. Write for your free copy to our Pfaudler Division, Dept. PR-129, Rochester 3, New York.

*FLUIDICS is a new Pfaudler Permutit program that provides a modern, imaginative approach for handling and processing liquids and gases more profitably.

FLUIDICS UPGRADES FEED WATER PURITY

Why a giant new power plant treats its boiler water

South Carolina Electric and Gas Company draws raw water from nearby Lake Murray for boiler feed in its new Silas C. McMeekin power station.



Bulk impurities in McMeekin's raw water are removed by Permutit Precipitator, which removes turbidity, iron and colorant matter.

The supply is ample, but here's what the water looks like under analysis:

Silica	9.0 ppm
Iron	0.8 ppm
Turbidity	15.0 ppm
Colorants	35.0 ppm
Electrolytes	50.0 ppm

Hardly the sort of water you can feed to a modern boiler. So you'll find a complete array of Permutit equipment at McMeekin. Gilbert Associates, Inc., Reading, Pa., consultants for McMeekin station, reports results from the Permutit system as follows:

Chemical feeders and a 350-gpm precipitator lower iron to 0.2 ppm, turbidity to less than 5 ppm and colorants to 2 ppm.

Three gravity filters further lower turbidity to less than 1 ppm.

Complete dimineralization plant. Permutit anion and cation exchangers reduce the scale-forming silica to an inoffensive .02 ppm, electrolytes to .75 ppm.

Fully automatic control cubicle remotely controls, monitors and records system operation at all times.

Such complete service is typical of the FLUIDICS program. If you have boiler feed water, process water or waste treatment requirements, Permutit offers you everything from initial survey to complete equipment systems.

FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in:

Germany	Pfaudler-Werke A.G.
Great Britain	Enamelled Metal Products Corp. Ltd.
Canada	Ideal Welding Co. Ltd.
Mexico	Arteacero-Pfaudler, S.A.
Japan	Shinko-Pfaudler Co., Ltd.

as well as four plants in the U.S.A.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

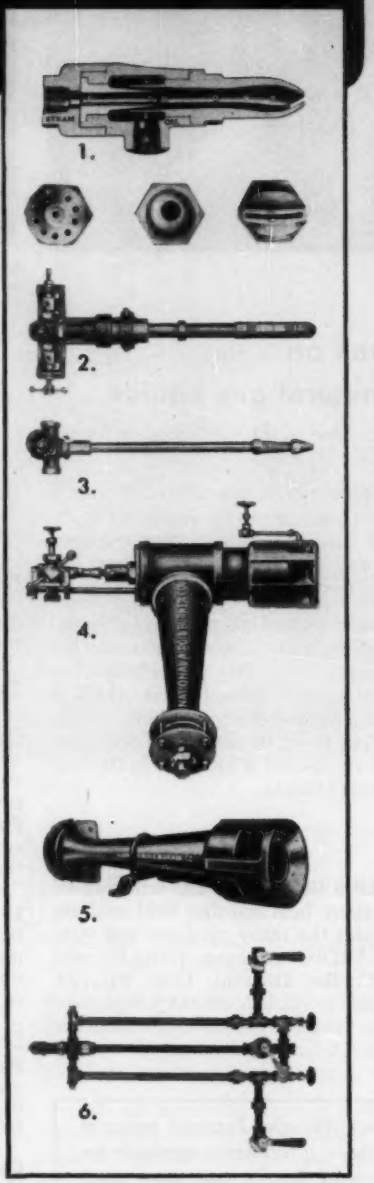
For more data on advertised products, use Readers' Service Cards, last page.

the Right LIQUID FUEL BURNER or GAS BURNER for Your Job

Whether you burn oil, gas or a combination of these fuels, there's a NATIONAL AIROIL BURNER for *your* needs.

Our more than 47 years' experience in the design, development and manufacture of all types of industrial gas-oil burners is at your service.

Ask us about your requirements . . . we'll gladly cooperate.



1. TYPE S-A
Uses steam or compressed air for atomization. Thoroughly atomizes and completely burns the lowest and cheapest grades of fuel oil and tars. Requires only low oil pressure and temperature.

2. TYPE S-A-L
Large capacity burner of steam atomizing type. Adaptable to large boilers or dual fuel systems. Is frequently used for firing boilers above existing coal grates—also for alternate firing on pulverized coal burners.

3. TYPE S-A-R
(Where steam, or gas is available for atomizing) safely and efficiently burns residuums obtained from process, including high temperature pitches and tars.

4. COMBINATION GAS AND OIL BURNER
An Airocool Inspirating Gas Burner combined with a Type S-A-R oil burner for safety and efficiency when burning process oils and gases as well as commercial fuels.

5. AIROCOOL GAS BURNER
Venturi type with patented long-life Airocool Nozzle assures trouble-free operation and provides low turndown without burnback.

6. TYPE S-A-D
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors all in combination with fuel oil.

National Airoil
BURNER COMPANY, INC.
Main Office & Factory: 1254 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD, HOUSTON 6, TEXAS

Suppliers . . .

erly project engineer for a number of leading electronics companies.

BECKMAN INSTRUMENTS, INC. has named **Stuart N. Davidson** corporate contracts administrator. He will administer certain government contracts and subcontracts assumed by the corporation as a whole, and prescribe basic contract administration procedures for Beckman's individual divisions and domestic subsidiaries. Davidson previously spent three years as senior contracts administrator with Northrop Aircraft, Inc.

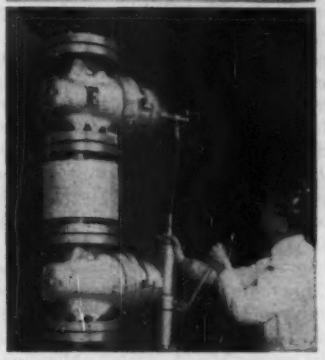
BENDIX COMPUTER DIVISION has named **Patrick J. Garrity** sales engineer for the company's general purpose digital computer line. **David C. States** moves to the Computer Division's training school where he will instruct classes on computer maintenance. For the past five years States has been with Remington Rand Univac Division, St. Paul, and International Electronics, Washington, D.C.

HARBISON-CARBORUNDUM CORP. has been formed by Harbison-Walker Refractories Co., and The Carborundum Co., Niagara Falls, N. Y. Owned on a 50-50 basis, Harbison-Carborundum will own and operate Carborundum's recently modernized and expanded Monofrax fused refractory plant in Falconer, N. Y. Additional new facilities are contemplated for the manufacture of chromite magnesia base fused refractories at a location not yet announced.

BENDIX COMPUTER DIVISION has named **Robert E. Todd** technical placement coordinator. He will be in charge of recruiting and placement of technical personnel for all phases of manufacturing, selling and servicing a Bendix computer line. Todd was previously with Burroughs Corp., Electro-Data Division. Before that, he was with Remington-Rand Corp., as a computer liaison engineer, and Glenn L. Martin Co., as an electronics technical writer.

H. K. PORTER CO. INC. has named **Howard Strandberg** New York District sales manager, Refractories Division. He previously was executive vice president in charge of operations for Seaboard Refractories Co., Fords, N. J. Strandberg attended New York University, City College of New York, and Rutgers University. He joined Seaboard in 1942, and served in various sales capacities until 1948, when he became vice president, sales.

GENERAL ANILINE & FILM CORP.'S Corporate Development Department has named **Dr. Joseph H. Wilkinson, Jr.,** director of development. He joined General Aniline & Film as a research chemist in the company's Central Research Laboratory, Easton, Pa., in 1943. In 1955 he was appointed new fields research manager for the Dyestuff & Chemical Division and made manager of the Central Research Laboratory, a position he held until his present appointment. Dr. Wilkinson at-

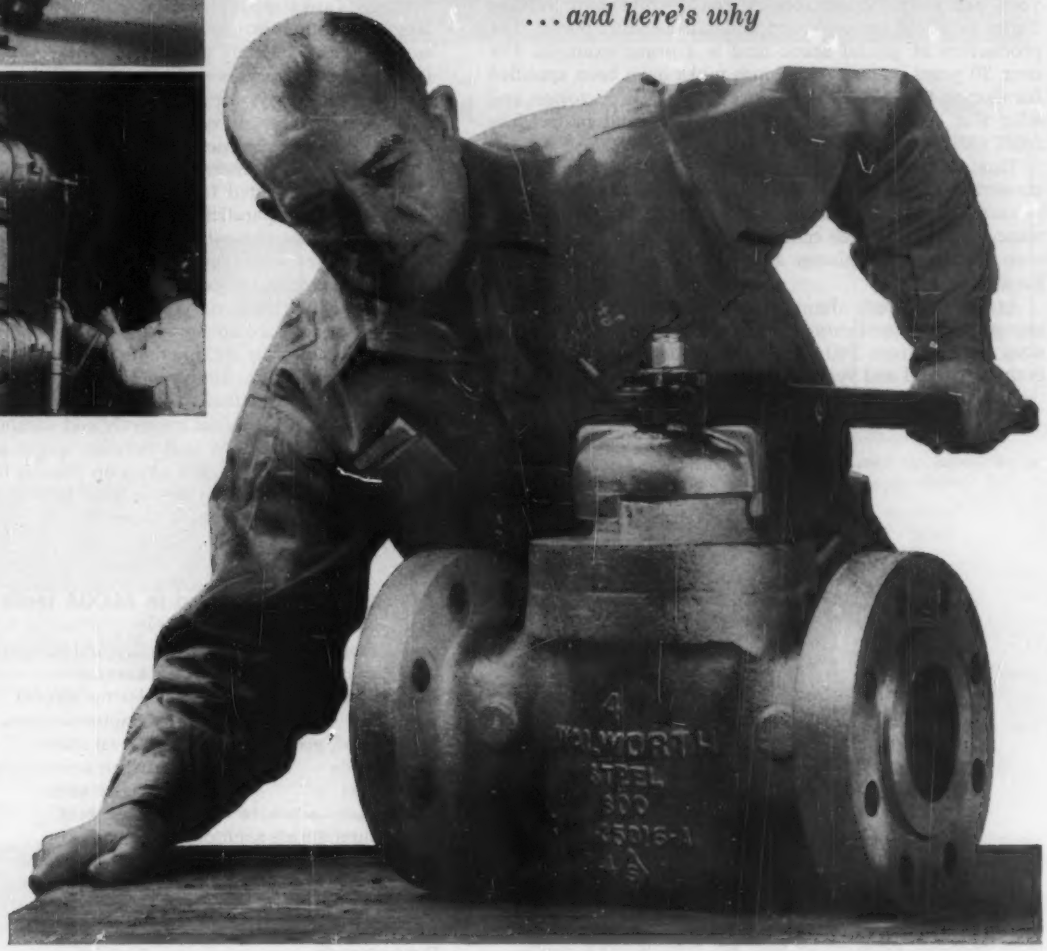


the **WALWORTH CUSTOMER**

wants a quick operating, sure, tight valve. He chooses a

WALWORTH LUBRICATED PLUG VALVE

... and here's why



When the Walworth Customer has to decide on a valve that will close fast and easily, he wants to know HOW fast... HOW easily. Tight closure? Of course. But can the valve be serviced under pressure? Yes. Still, he tries one himself.

In the Walworth Lubricated Plug Valve he finds 100% tight closure because it is lubricant-sealed against leakage. He finds it opens or closes with a quarter turn. Then, and only then, he's ready to buy. If that's the way you like to buy valves, we want you, too, for a Walworth Customer. For details on all types and ratings of Walworth Lubricated Plug Valves, ask your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

For more data on advertised products, use Readers' Service Cards, last page.

See why ALCOA ALUMINUM makes a good design habit

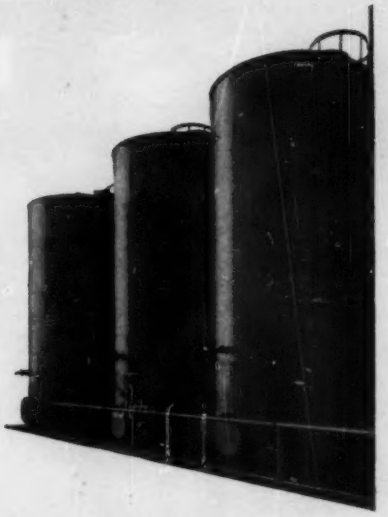
Requirement: A better way to store process liquids and gases

Key to Good Design: Use Alcoa Aluminum Storage Tanks

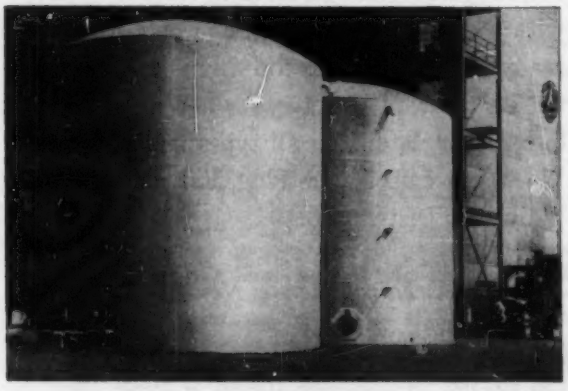
Whether product storage is an intermediate or final step in your processing operation, ALCOA® Aluminum Storage Tanks can help cut costs and maintain product purity. The production of glacial acetic acid is a prime example. For over 30 years ALCOA Aluminum tanks have been specified for storing this chemical because they resist corrosion and offer real economies in initial investment and in freedom from maintenance costs.

Thousands of aluminum tanks and tank cars have been constructed for the transport and storage of such chemicals as ammonium nitrate solutions, acrylonitrile, cryogenic substances and sour crude oils. Some of the many other products for which aluminum alloy tanks are well suited are listed below.

ALCOA can supply aluminum storage tanks for practically any processing application. They are made in a number of sizes ranging from 580 to 21,480 gal and are available in both horizontal and vertical construction.



Oleic acid is one of the many chemicals often stored in aluminum tanks. Aluminum preserves the color and purity of this product.



These aluminum storage tanks maintain the purity of steam condensate for a large public utility.

Fabricated from 3003 aluminum alloy, ALCOA Standard Storage Tanks measure 10 ft in diameter with varying lengths for different capacities. ALCOA also supplies special storage tanks to many processors. These can be furnished in intermediate lengths and capacities, and in a wide range of aluminum alloys for many process applications.

ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy storage tanks and other equipment best suited for your particular process application. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address on the coupon, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

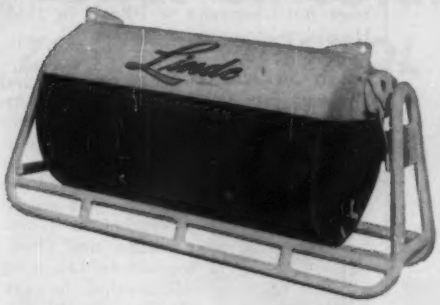
You can also take advantage of the wide selection of free ALCOA literature on aluminum for storage tanks and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward your material promptly and without obligation.

During 1959, ALCOA will conduct engineering conferences in a number of major cities on process industries applications of aluminum. Contact your nearest ALCOA sales office for full particulars and dates.

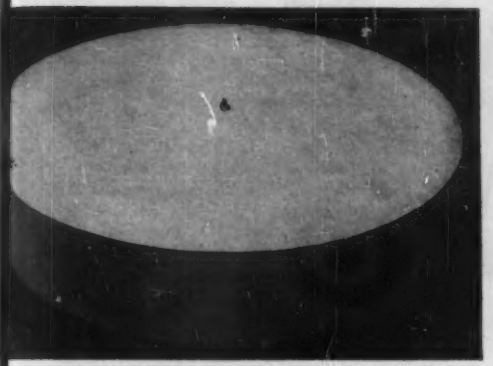
Typical chemicals stored in ALCOA tanks

Acetaldehyde	Glycerol phosphate
Acetic acid, glacial	Lacquer
Acetic anhydride	Methyl alcohol
Acetone	Napthenic acids
Acrylic acid, glacial	Naval stores
Acrylonitrile	Nitric acid (above 82% conc.)
Adipic acid	Nylon salts
Ammonium carbonate	Oleic acid
Ammonium nitrate solutions	Phenol
Ammonium thioglycolate	Propyl alcohols
Amyl mercaptan	Propylene glycol
Animal oils	Resins
Benzene	Rosin
Butyl alcohols	Sorbitol
Cellulose acetate	Solvents
Edible oils	Stearic acid
Ethyl acetate	Sugar solutions
Ethyl alcohol	Toluene
Ethylene glycol	Trichlorobenzene
Fatty acids	Turpentine
Gasoline	Water (distilled or deionized)
Glycerine (natural & synthetic)	Waxes

Fatty acids are not discolored by contact with aluminum.



Aluminum's light weight assures easy handling and storage for this 600-liter nitrogen container. The tank is fabricated from Alcoa Aluminum Alloy 5154.

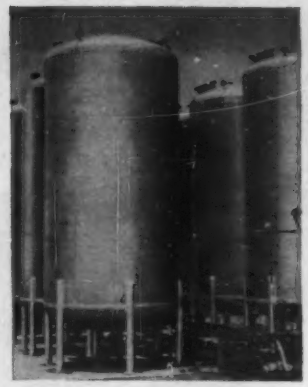


The world's largest all-aluminum tank stores 2½ million gal of ammonium nitrate at 180°F. Prime consideration here was the need for uninterrupted storage service with a minimum of maintenance. The tank stands 26 ft high, and has a diameter of 128 ft.

Typical mechanical properties of Alcoa Aluminum Alloys

Alloy and Temper	Tension			Hardness, (2)	Shear Ultimate ksi	Fatigue Endurance Limit, ksi	Modulus of Elasticity ksi
	Strength, Ultimate	ksi Yield	Elongation % in 2 in. (1)				
5052-O	28	13	25	47	18	16	10,200
5083-O	42	21	22	73	26		10,300
5086-O	38	17	22	65	23		10,300
5154-O	35	17	27	60	22	17	10,200
5454-O	36	17	22	62	23		10,200
5456-O	45	23	24	75	28		10,300

(1) 1/16-in. thick specimen
(2) Brinell; 500-kg load, 10-mm ball



ASME design stress values for various Alcoa Aluminum Alloys (psi at 100 degrees F)

5052..... 6,250 psi
5083.....10,000 psi
5086..... 8,700 psi
5154..... 7,350 psi
5456.....10,500 psi

Alcoa standard tanks are constructed of stock components and are available for fast delivery. They provide the safest storage for a wide variety of chemicals, petrochemicals and petroleum products.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

For exciting drama watch "ALCOA THEATRE," alternate Mondays, NBC-TV, and "ALCOA PRESENTS," every Tuesday, ABC-TV.

Aluminum Company of America
874-M Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for storage tanks and other uses in the process industries:

- ☐ 10387 Alcoa Standard Storage Tanks
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 10508 Cleaning and Maintenance
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20265 Have You Tried Aluminum in Your Refinery?
- ☐ GL93 Aluminum in the Pulp and Paper Industry
- ☐ 20268 Resistance of Aluminum Alloys to Fresh Waters

Name_____

Company_____ Title_____

Address_____

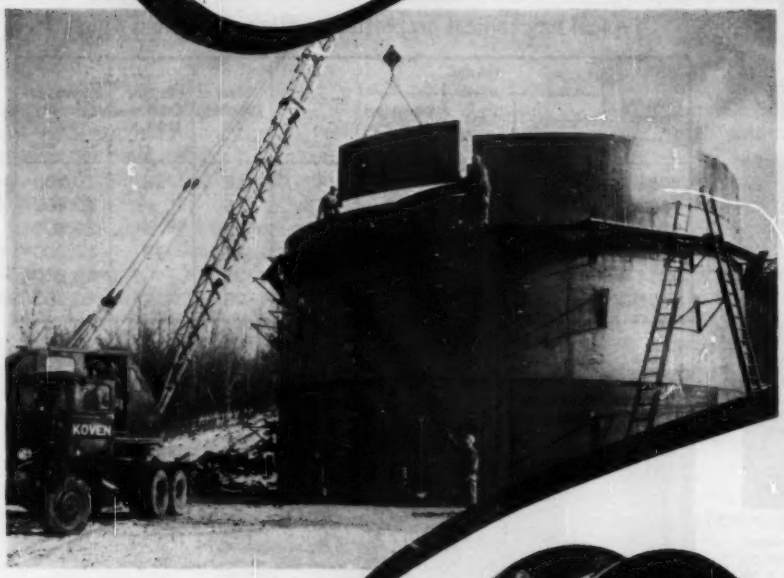
City_____ State_____

For more data on advertised products, use Readers' Service Cards, last page.

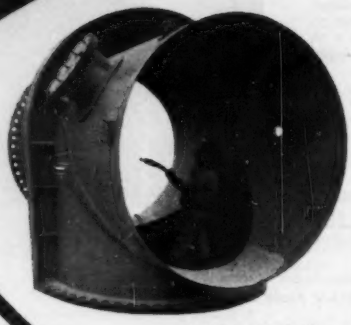
IF Koven MADE - IT'S WELL MADE!

FOR QUALITY CONTROL

- magnetic particle inspection.
- mass spectrometer testing.
- penetrant dye checking.
- x-ray inspection.



50' x 30' Field Erected Acid Storage Tank.



Stainless Steel Elbow ASME Construction, Approximately 10' dia. 16' long.

Koven equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; large diameter fabricated piping and plate exhaust ducts; shop and field erected storage tanks.

SPECIALISTS IN INTRICATE FABRICATION USING: STAINLESS STEEL • ALUMINUM • MONEL • NICKEL • INCONEL • ALL CLAD MATERIALS • NICKEL PLATED STEEL

Fabrication to all A.S.M.E. Codes

See Sweet's Catalog File and Chemical Engineering Catalog

Call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550.

Telephone:
New Jersey:
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MArket 3-8150
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REctor 2-1160

STEEL PLATE FABRICATORS ASSOCIATION

Koven FABRICATORS, INC.

93-P East Dickerson Street, Dover, New Jersey

Suppliers . . .

tended Southern Illinois University and received his Ph.D. degree in chemistry from the University of Illinois in 1943. He will headquarter at Marion, Ill.

NALCO CHEMICAL CO.'S vice president and director, **James L. Gibboney,** will increase his activities in the organization's international and general management operations. Since 1955, he has served as head of the Transportation and Overseas divisions, and will continue to work closely with the former. Gibboney first joined Nalco in 1932 as a service engineer. He was named assistant to a vice president in 1943, assistant vice president in 1947, vice president in 1951 and director in 1957.

Gibboney

MIDWEST PIPING CO., INC. has named **Norman B. Champ, Jr.,** to the board succeeding **Guy L. Morrill,** retired. A graduate of Massachusetts Institute of Technology in mechanical engineering, Champ, who also holds a M.S. degree from the Harvard Graduate School of Business Administration, came to Midwest in 1953.

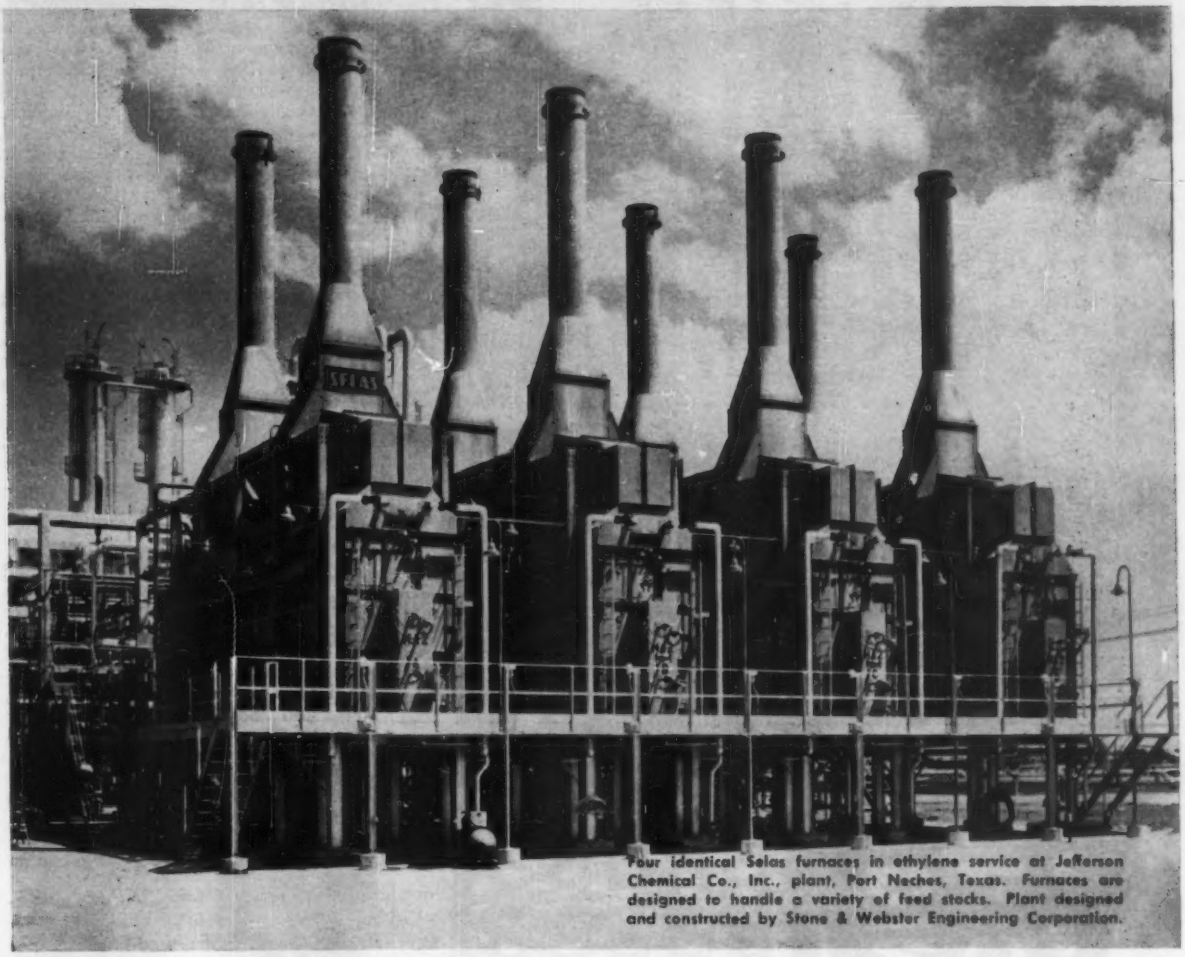
ROCKWELL MANUFACTURING CO. plans to build a new 150,000-square-foot addition to its plant at Pinneberg, West Germany, for the manufacture of liquid meters, valves and woodworking power tools for European and world markets. The new building will also house production facilities for larger sizes of Rockwell-Nordstrom lubricated plug valves.

PETROLITE CORP. has started construction on a 12,000-square-foot, three-story addition to Tretolite Company Division's present administration building, Webster Groves, Mo. The new addition will house the Tretolite administrative building, Webster Groves, Mo. The new addition will house the Tretolite administrative offices and executive sales personnel and include Petrolite Corp., executive offices and Advertising Department.

GENERAL KINETICS CORP. has acquired from P-K Industries, Inc., patent licenses to produce and sell the P-K Paul valve and has taken over the latter's technical personnel for that purpose. The new corporation will produce the full line of P-K Paul valves. General Kinetics will handle manufacturing at the North Arlington plant of P-K Industries, Inc., until current negotiations for new production and research facilities have been completed.

GENESYS CORP.'S new sales manager, **Robert M. Cornforth,** will head sales activities of the firm's control computer system for process and pipeline applications. Cornforth was previously manager

JEFFERSON CHEMICAL
relies on Selas Gradiation® Heating for
ZONE CONTROL • PRECISENESS • UNIFORMITY



Four identical Selas furnaces in ethylene service at Jefferson Chemical Co., Inc., plant, Port Neches, Texas. Furnaces are designed to handle a variety of feed stocks. Plant designed and constructed by Stone & Webster Engineering Corporation.

In ethylene production, the following inherent features of Gradiation heating have been translated, at Jefferson Chemical Co., into . . . *Longer on-stream periods . . . fixed amount of production with less feed stock . . . greater depth of cracking when limited by actual metal temperatures:*

- Zone Control . . . Duradiant® burners can be adjusted to desired heat pattern, in horizontal rows, to produce optimum reactions in pyrolysis.
- Uniformity of heating . . . even-heat distribution along and around tubes, increases tube life by eliminating hot spots, minimizing coke formation.
- Preciseness of heating . . . complete combustion within Duradiant burner cup permits placing burners close to tubes . . . achieving fast heat-up and instantaneous response to controller demand.
- Versatility . . . Gradiation heaters can handle a variety of feedstocks, interchangeably, under optimum conditions.

May we arrange for a Selas field engineer to discuss your heat processing needs with you? For this service . . . without cost or obligation to you . . . or for a copy of Bulletin 712 "Gradiation Heating for Petroleum and Chemical Processing," write to Mr. K. W. Fleischer, vice president, Fluid Processing Div., Selas Corporation of America, Dresher, Pa.

Gradiation and Duradiant are tradenames of Selas Corporation of America.

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT • DESIGN • CONSTRUCTION

This tube support is 21'6" long; 6'7" wide and weighs 8900 pounds. It looks like a single casting. Actually it is made up of three sections welded together in zig-zag strips across the face. It's a Duraloy HH casting destined for an oil refinery cracking still.

Welding is assuming greater and greater importance in the production of high alloy castings. Often it is the only way to produce large tonnage or unusually shaped pieces. During our many years of experience in producing both high alloy static and centrifugal castings, we have developed sound welding techniques for such castings. Carbon steel welding techniques won't serve. It takes special know-how for chrome-iron and chrome-nickel.

You can rest assured that if the chrome-iron or chrome-nickel castings you order from us require any welding, it will be done skillfully.

Suppliers . . .

of refinery sales with Kaiser Engineers. He is a member of API, AIChE and CNGA. He received his M.S. degree in chemical engineering from Massachusetts Institute of Technology in 1937.

TRACERLAB CO. has appointed **Leon Leventhal** manager of the Technical Services Department. He has been with Tracerlab since 1949 and prior to his promotion was the head of the Special Projects Division, Technical Department. Listed in American Men of Science, Leventhal received his B.S. degree in chemistry from the University of California, a B.S. degree in chemical engineering from Virginia Polytechnic Institute, and a M.S. degree in chemistry from UCLA.

HOUDAILLE INDUSTRIES, INC., has named **Eric G. Boehm** general manager of the Manzel Division, Buffalo, N. Y. He has been with Houdaille and its predecessor companies for more than 20 years in various management and production-executive capacities. He was formerly general manager of the Buffalo Hydraulics Division, and more recently general manager of the Buffalo Bolt Division, Buffalo-Eclipse Corp., North Tonawanda, N. Y.

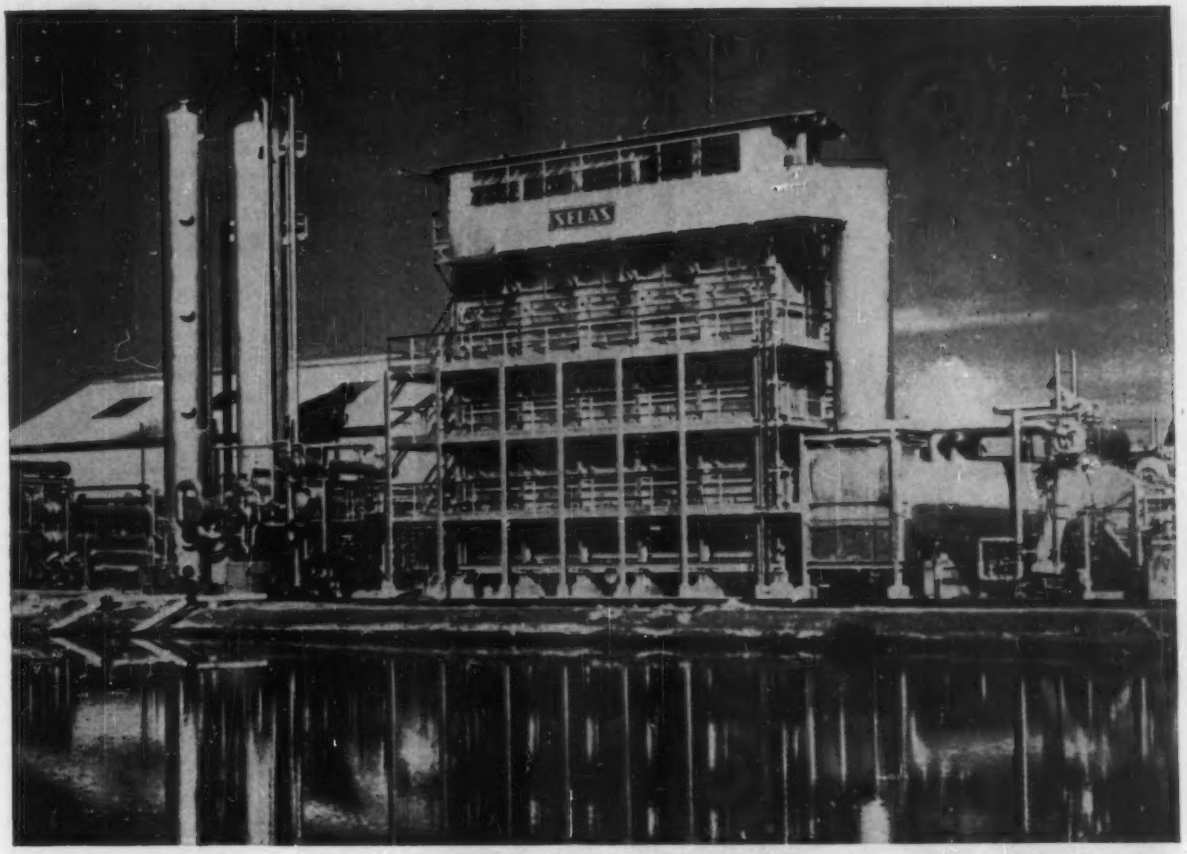
PUROLATOR PRODUCTS, INC., has formed two wholly-owned foreign subsidiaries which will market and distribute filter products on a world-wide basis. Purolator Products A. G., Zug, Switzerland will serve all European markets, including England, France, Germany, Spain, Italy, and the British Commonwealth. Purolator Inter-America Corp., incorporated to qualify as a Western Hemisphere trade corporation, was set up to service markets in Mexico, Central and South America, and the Caribbean area.

Gloor

Wakefield

CHEMETRON CORP.'S Tube Turns Division has named **James M. Gloor** works manager, Louisville, Ky., plant. Gloor is a member of the American Society of Plant Engineers and the Society for Advancement of Management. He joined Tube Turns in 1951. **Morry T. Wakefield,** formerly industrial relations director, succeeds Gloor as production superintendent. He joined Tube Turns as a product engineer in 1946. **Max B. Densford,** wage and salary administrator, is promoted to personnel manager to assume duties vacated by Wakefield. **Henry H. George** has been appointed

For more data on advertised products, use Readers' Service Cards, last page.



California Ammonia Co. is owned in partnership by Best Fertilizer Co., Lathrop, Calif., and a group of farmers. Using Calamco ammonia, Best produces ammonium sulfate and over 20 different grades of pelleted ammonium phosphates and dry mixes.

CALAMCO Relies on Selas Gradiation® Heating to Meet Varying Hydrogen Production Demands

This new Selas steam-methane reforming furnace — installed at California Ammonia Co.'s Lathrop, California, anhydrous ammonia plant—provides the necessary versatility to meet a wide variety of production demands.

Controlled heat, delivered to the vertical tubes by Duradiant® burners positioned in rows along the furnace walls, assures:

- Preciseness of heating . . complete combustion within Duradiant burner cup permits placing burners close to tubes . . achieving fast heat-up and instantaneous response to controller demand.
- Heat uniformity . . even-heat distribution along and around tubes increases tube life by eliminating hot spots, minimizing coke formation.
- Versatility . . Duradiant burners, readily adjustable to desired heat pattern (in either horizontal or vertical rows), provide CALAMCO with an extremely versatile heat processing tool.

For example, the ability to alter burner pattern, enables CALAMCO to produce hydrogen under any of the following conditions:

- Boost throughput to meet increased production demands, without changing conversion.
- Increase conversion without changing throughput . . resulting in higher product yield.
- Operate for maximum thermal efficiency, at design throughput and conversion.
- Operate at lower tube wall temperature, at design throughput and conversion.

May we arrange for a Selas field engineer to discuss your heat processing needs with you? For this service . . without cost or obligation to you . . or for a copy of Bulletin 712 "Gradiation Heating for Petroleum and Chemical Processing" and article reprint "Uniform Heat Raises Reformer Output," write to Mr. K. W. Fleischer, vice president, Fluid Processing Div., Selas Corporation of America, Dresher, Pa.

Gradiation and Duradiant are registered tradenames of Selas Corporation of America

SELAS CORPORATION OF AMERICA DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers

DEVELOPMENT · DESIGN · CONSTRUCTION

For more data on advertised products, use Readers' Service Cards, last page.

20% lighter than cotton duck but just as sturdy and flexible... Quaker Thermoid OS&D Hose

Strong but light. Extremely rugged but flexible. That's Thermoid-Quaker "Quaflex" Oil Suction and Discharge Hose.

It's lighter than reinforced cotton-duck hose, but it won't expand under pressure. It won't collapse under suction. It's exceptionally kink- and crush-resistant.

For more details, call your local Thermoid distributor, or write to *Thermoid Division, H. K. Porter Company, Inc., Tacony and Comly Streets, Philadelphia 24, Pa.*

HERE'S WHY: Separate layers of nylon tire cord surround a helix of high-tensile spring-steel wire in Thermoid-Quaker "Quaflex" Oil Suction and Discharge Hose. That's why it's just as sturdy and flexible as cotton duck, although lighter in weight.

Nylon tire cord for lightness, strength.

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H.K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO, S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.

Suppliers . . .

chief engineer, Product Engineering and Research Department. He joined Tube Turns as manager of research in 1944. **Everett C. Rodabaugh,** principal research engineer, was assigned to added duties as head of a newly formed Process Research Group. He has been a research engineer with Tube Turns since 1946. **Fred C. Smith,** director of quality control, who joined Tube Turns as chief metallurgist in 1943, was assigned to added duties as special research project head. **Arthur McCutchan,** senior engineer in product engineering and research from 1947-57, has rejoined Tube Turns as a special projects engineer.

CHEMETRON CORP.'S Chemical Products Division has named **George F. Foy** commercial developments manager, New York. He will be concerned primarily with marketing problems and with the introduction of new products to the chemical process industries. He will coordinate commercial development activities of the division's Girdler Catalysts Unit, Louisville; Holland Color & Chemical Co., Holland, Mich.; Dunham Chemicals, Chicago, and Rock Hill Laboratory and Crestwood Chemicals operation, Newport, Tenn. Before joining Chemetron, Foy was in charge of commercial development for Shulton Fine Chemicals, Clifton, N. J.

Foy

WOLVERINE TUBE DIVISION has promoted **R. E. Seaton** to manager of processing and power sales. He joined the company as technical sales representative, New York, in 1955. In 1957 he became Technical Sales Supervisor. Seaton will headquarter in Allen Park, Mich.

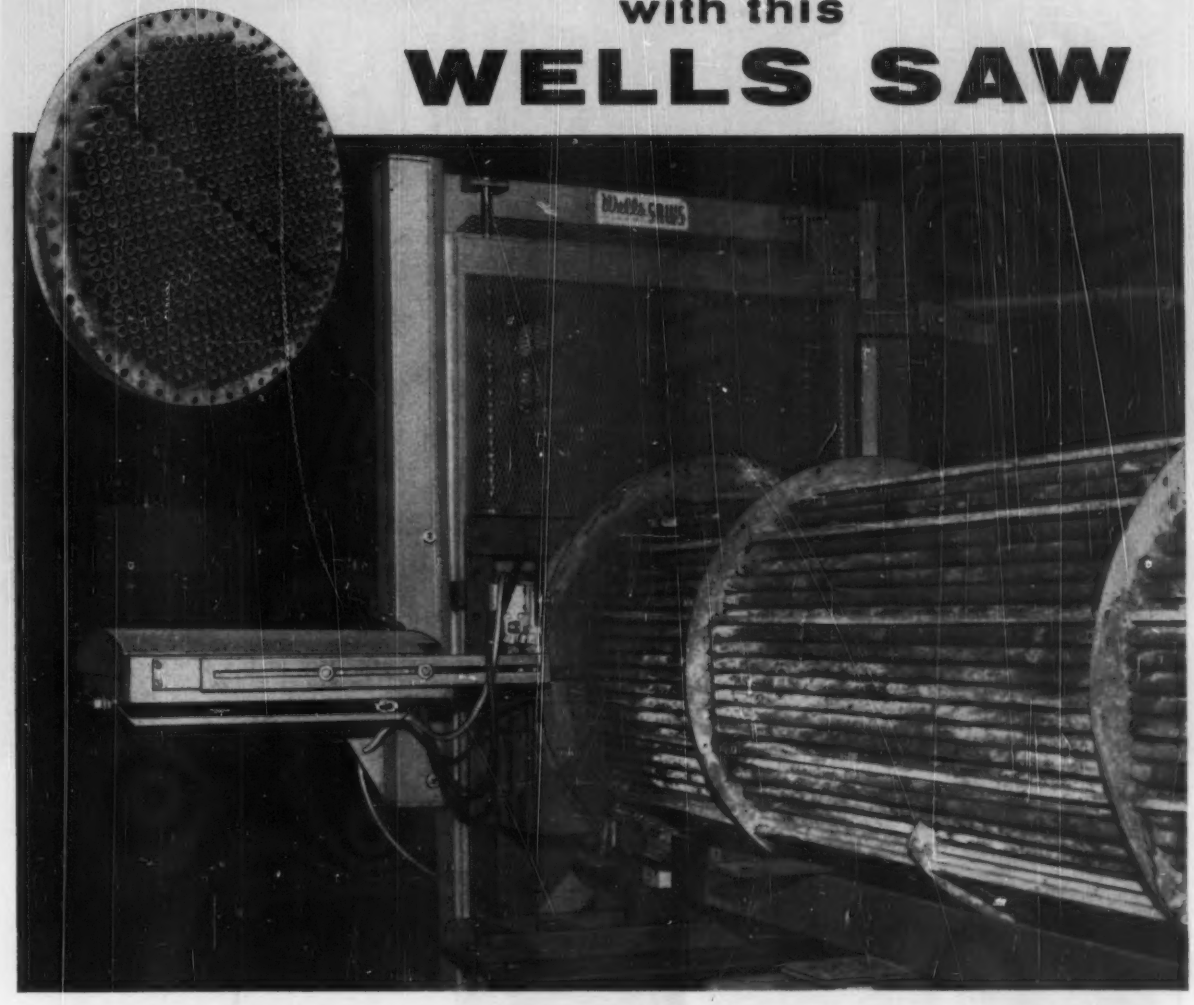
UNITED ELECTRIC CONTROLS CO. has established a manufacturing facility in Canada. The new firm, United Electric Controls (Canada) Ltd., is in Dorval, Quebec. **Lorne J. Inglis** has been appointed generai manager.

AMERICAN METER CO. has acquired all of the outstanding capital stock of Granberg Corp., Oakland, Calif. Granberg manufactures tank truck, bulk plant and pipeline petroleum meters and pumps.

PANELLIT, INC. has appointed **Stanley Knoblock** chief engineer of its Eastern Division, New York. He was formerly chief instrumentation engineer of Bechtel Associates, New York.

HOOKER CHEMICAL CORP. will establish corporate headquarters in New York some months hence. The decision involves only 15-20 people in certain corporate departments out of approximately 461 corporate personnel and a total of about 2550 employed by Hooker at Ni-

Cut Heat Exchanger Tube Bundles
SAFELY . . . QUICKLY . . . CLEANLY . . .
with this
WELLS SAW



TYPICAL OPERATING DATA
(job illustrated above)

Type of Bundle	Debutanizer Condenser
Stationary Head	40½"
Sheet Floating Head	35-11/16"
Head Thickness	3¼"
Type of Material	Brass
Number of Tubes	480
Diameter of Tubes	1"
Gauge of Tubes	14
Type of Material	Copper Nickel
Size of Blades	21'0" x 1¼" x .042"
Teeth per Inch	8
Blade Speed	135 FPM
Cutting Time	165 Minutes

Write for Bulletin SM658 →

This is the Wells Model 12-20G-60 in action. Special Heavy-Duty Cut-Off Machines like this, developed by Wells Manufacturing Corporation, specifically for cutting tube bundles, are now doing the job efficiently in many oil refineries and chemical plants.

Model 12-20G makes safe and easy work of this difficult, hazardous, time consuming job, and materially reduces the cost of heat exchanger maintenance.

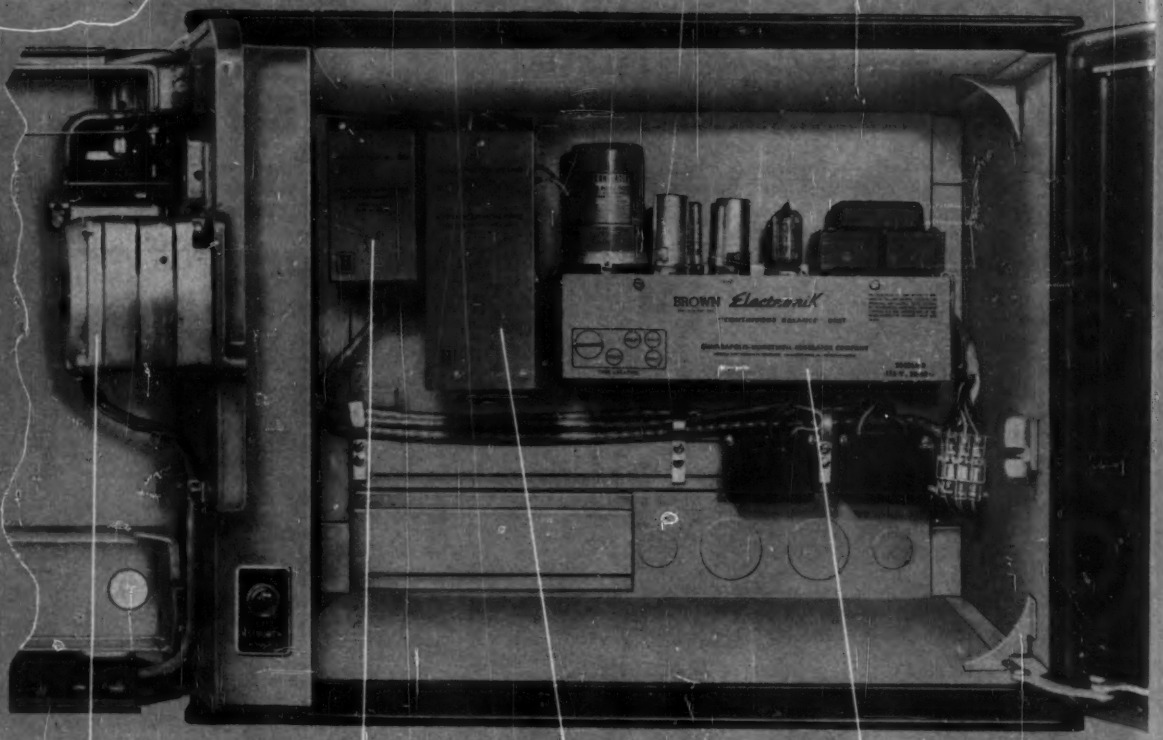
Standard models are available for cutting 48" or 60" diameter bundles. J.I.C. electrical standards and modifications of basic design are available to meet individual requirements.

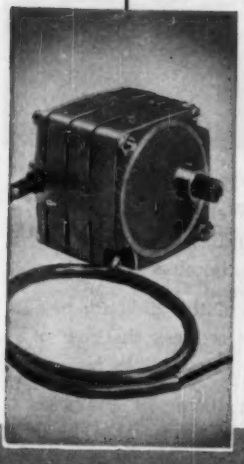
If a safer, more practical, less costly method of cutting tube bundles is of interest to you, write for complete information.

Wells SAWS
Wells®

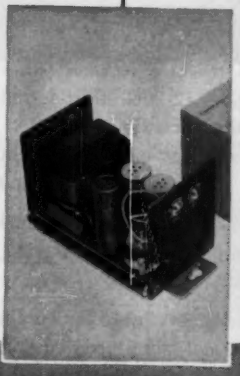
The Pioneers of Horizontal
METAL CUTTING BAND SAWS
WELLS MANUFACTURING CORPORATION
880 Service Road — Three Rivers, Mich.

For more data on advertised products, use Readers' Service Cards, last page.

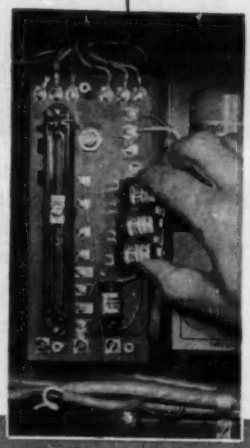




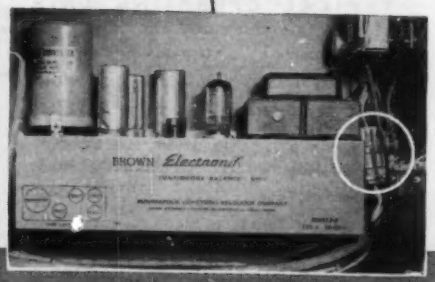
Servo Motor has sectional housing, leakproof oil wick, printed circuits for simplified servicing. Any major part can be replaced in 2 minutes.



Constant Voltage Module—Uses Zener diodes and an ambient temperature compensator to replace standardizing mechanism.



Measuring Circuit Module—Contains easily-changed range spool panels and vernier adjustment. Range is changed simply by replacing screw-clip panels of fixed resistors.



Amplifier Module—Quick-connect design permits fast, easy removal for servicing and replacement. Circle shows quick connect plug.

THESE FOUR NEW FEATURES ARE STANDARD WITH ALL *ElectroniK* POTENTIOMETERS

New modular design...

makes ElectroniK potentiometers easier to use and maintain

Now, four great new features add new operating and servicing ease to all *ElectroniK* circular and strip chart potentiometers.

- **New servo and chart drive motors are sectionalized so that any major part can be replaced in two minutes.**
- **A new constant voltage unit replaces batteries, standard cells and standardizing mechanisms.**
- **A new measuring circuit, with quick-change range spools, simplifies range changing and reduces stray pickup.**
- **A quick-connect feature lets you remove the amplifier for service and replace it quickly.**

Now, modular design is combined with the traditional precision of *ElectroniK* potentiometers, to give you a greater value than ever in accurate, dependable measurement and control.

For full details, call your nearby Honeywell field engineer today. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

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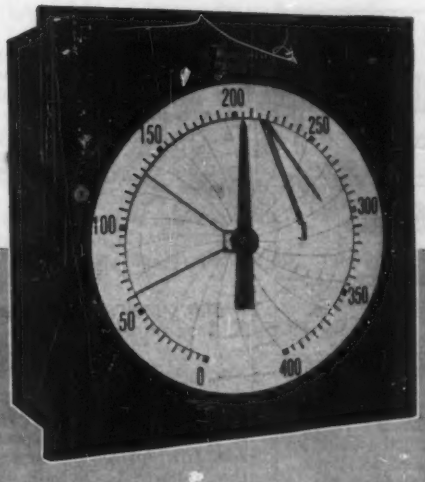

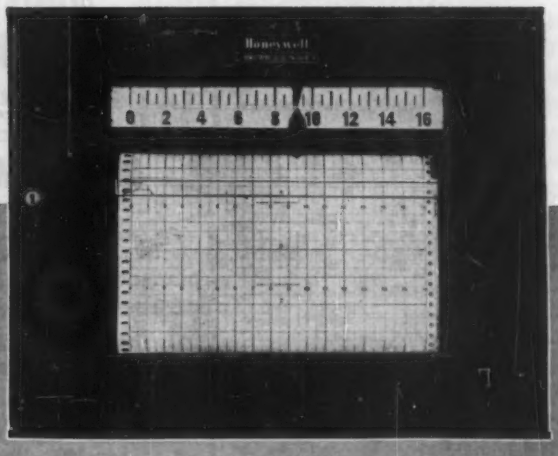

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HELP WANTED

MECHANICAL ENGINEER

Graduate Mechanical Engineer with minimum of four years experience in petroleum refinery or related engineering. Will be responsible for mechanical design and cost estimate of refinery processing equipment.

Duties will be closely integrated with operation of a modern, independent refinery which includes crude distillation, catalytic cracking, polymerization, coking, hydro-desulfurization, catalytic reforming, alkylation, and utilities.

Send complete resume of education and experience, including salary requirements. All replies confidential.

GREAT NORTHERN OIL COMPANY
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ST. PAUL 1, MINNESOTA
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MANAGER

Engineering Contracting Company, well financed, good reputation, needs general manager. Good opportunity available for a man experienced in industrial, petrochemical and refinery engineering and construction.

All replies held in confidence. Submit resume to Post Office Box 2963, Houston 1, Texas.

PROCESS ENGINEER

Engineering graduate experienced in the process design of various types of petroleum refining process units required by a midwestern engineering and construction firm. Please submit resume and photograph indicating education, experience, and salary requirements to Box 322-R, PETROLEUM REFINER, Houston, Texas.

CHEMICAL OR MECHANICAL ENGINEER, Eastern U. S. Manufacturer requires experienced Engineer for Process and Mechanical Design of Fired Heaters. Age 30-40. Minimum Experience—5 years. Ch.E. or M.E. degree preferred. All replies to Box 323-R, PETROLEUM REFINER, Houston, Texas, will be treated confidentially.

SITUATIONS WANTED

■ Chemical-Engineer—B.Sc. Ch.E., 1942 M.A.I. Ch.E. Seventeen years experience, process, job, and sales engineer for petroleum refineries and petrochemical plants. Perfect German, some Dutch and Russian. Now senior project engineer in Germany. Desire senior position overseas with engineering or oil company. Box 328-F, PETROLEUM REFINER, Houston, Texas.

■ Corrosion - Metallurgical - Inspection - Welding Engineer. Seven years major refining, petrochemical plants. Supervisory experience. B.S. Met.E. Age 30. $10,000 present. Box 324-R, PETROLEUM REFINER, Houston, Texas.

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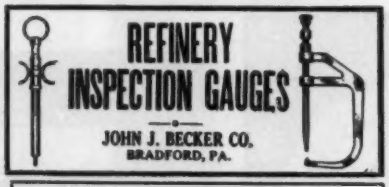

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Suppliers . . .

agara Falls. Many corporate functions which can be performed more effectively at Niagara Falls will continue to be handled there entirely.

U. S. INDUSTRIES, INC., has named **Thomas H. Mullen** director of customer relations at its Pompano Beach, Fla., Technical Center. He will direct all proposal and contract administration activities of the center, which is engaged in long-range product development for the USI manufacturing divisions, and a wide-range research and development program for the armed forces. Before joining the USI Technical Center, Mullen was manager of program evaluation for Vertol Aircraft Corp., where he served since 1951 in engineering, contract administration and Washington representation. He holds a degree in Aeronautical Engineering from the University of Notre Dame and has done graduate work in engineering management at George Washington University.

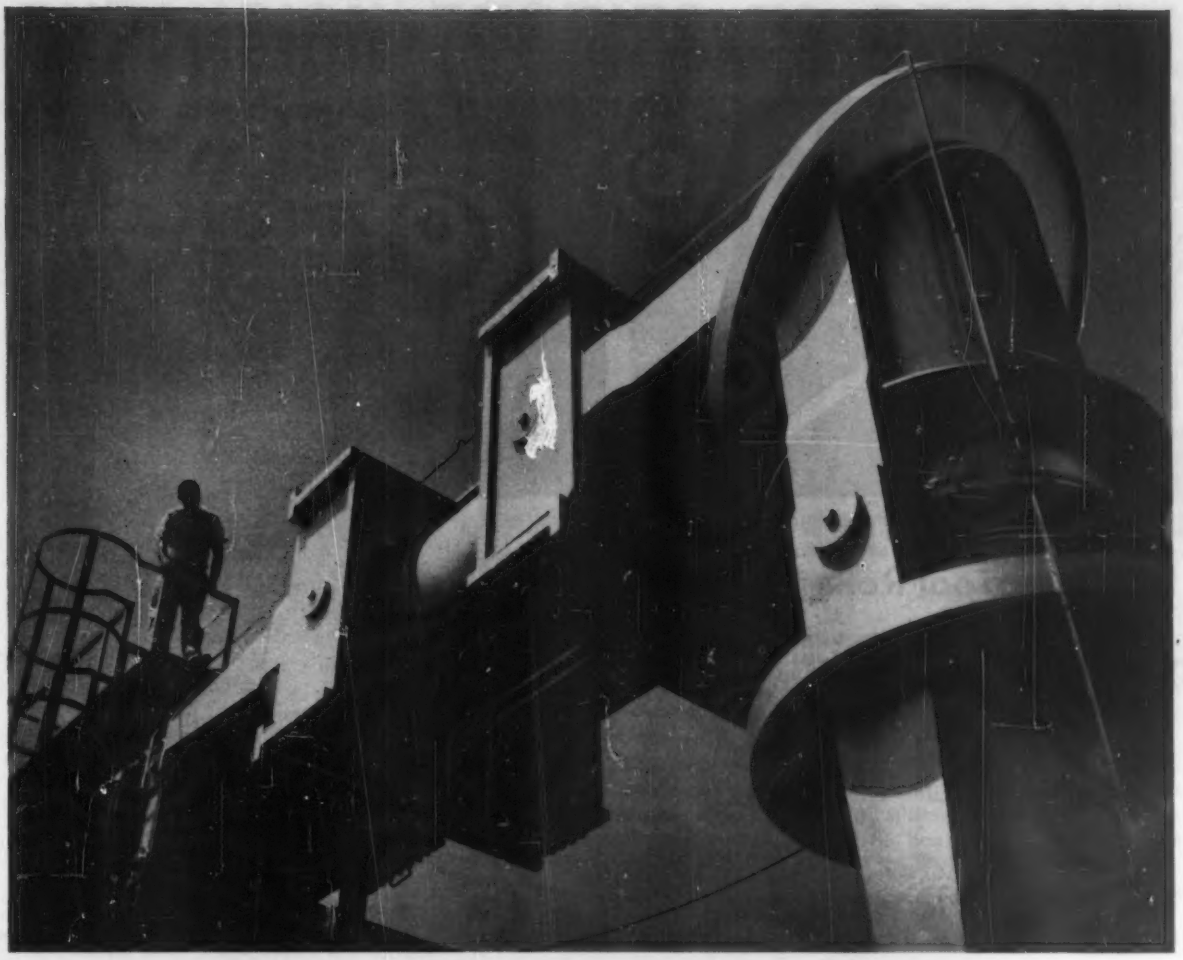
Mullen

LINDE CO. has named **James A. Hudson** Western sales manager of bulk gas sales. Formerly Midwestern manager of gas products sales, he joined Union Carbide Corp., in 1934. A year later he transferred to Linde Co. Since then he has worked closely with Midwestern steel mills in developing metallurgical processes and treating applications.

NUODEX PRODUCTS CO.'S Plastics Industry Division has named **Joseph P. Palumbo** manager. He was formerly product sales manager for organic peroxide catalysts and accelerators, and, in his new position, will administer the entire plastics industry line. Palumbo received his B.S. degree in chemistry from Columbia University.

GENERAL DYESTUFF CO. has named **Carl A. Bergman** chemical sales manager, Southern Region. He will direct and coordinate chemical sales in the Charlotte and Chattanooga branches. Bergman has been with General Dyestuff's parent company, General Aniline & Film Corp., for more than 22 years. Before his promotion, he was assistant branch manager of Antara Chemicals Co., another sales division of General Aniline & Film.

NALCO CHEMICAL CO. has named **Herbert S. Johnson** vice president in charge of marketing. He will coordinate and assist in sales operations of various Nalco divisions, and will work on advertising, marketing research, pricing studies and long-range planning. **Leonard R. Robinson, Jr.,** replaces Johnson as manager of the Industrial Division. Robinson had been field personnel manager before his promotion.



MACH 5...

with the help of

ADSCO CORRUFLEX EXPANSION JOINTS

ADSCO DIVISION
20 MILBURN STREET
BUFFALO 12, NEW YORK

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

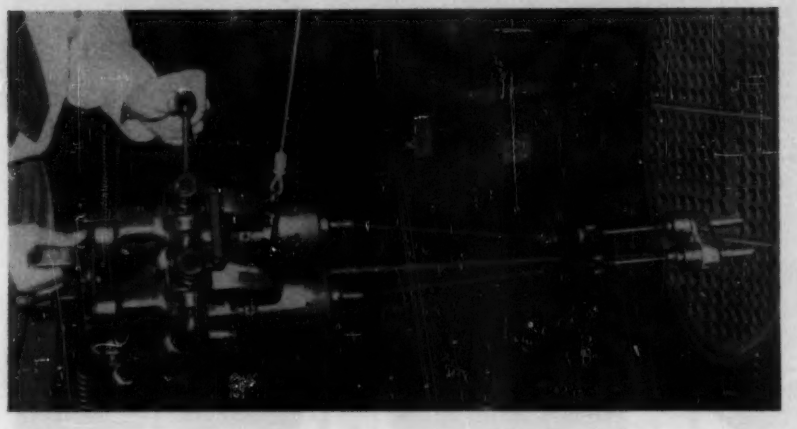
Wind rushing through a wind tunnel at the Arnold Engineering Development Center, Tullahoma, Tenn., reaches a speed of five times the speed of sound. That is 3800 miles an hour. Under this condition, this Air Force Research and Development Command Center can test aircraft, missiles and projectiles under simulated characteristics of high-speed flight.

But the air-supply ducting grows and twists under the high temperatures and pressures of the air rushing inside. Something must absorb this movement occurring in three directions, or the ducting would buckle. Easily and efficiently, the movement is absorbed by a combination of Adsco Corruflex Hinge and Universal Expansion Joints, shown above in a section of the ducting.

The design and development of these expansion joints to customer's specialized requirements is only one of the many engineering feats performed by Adsco in recent years. Consult Adsco the next time you need help on piping engineering.

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment & Literature...



Expander Tool Rolls 1,800 Tubes Per Hour

A new dual pneumatically operated tube expansion control unit features a double spindle design and greatly increases tube rolling capacity.

Tests of this unique tool show that it will easily roll up to 30 tubes per minute, depending on the speed of the motor used. This results in less strain on the operator and all tubes are rolled to uniformly tight joints without leakage.

The new rolling tool combines two Model 1000 Airetrol controls into one operating unit, making possible the rolling of approximately 1,800 tubes per hour.

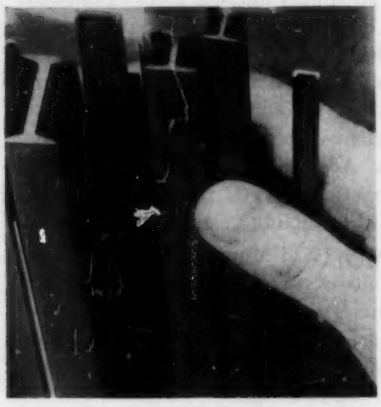
The Dual Airetrol automatically controls tube expansion by precise measurement of torque output and is accurate to 0.001 of an inch. This extreme accuracy is obtained through the sturdy, torque sensing cam mechanism which is completely unaffected by variance in air pressure.

A finger-tip micrometer adjustment is quickly set to the desired torque without using any tool, and the calibrated ring permits setting as low as 0.5 foot pounds and up to 37 foot pounds torque at 90 psi.

Air operation of the Dual Spindle rolling tool makes it very economical to use and it will roll tubes ranging in size from ½ to 1 inch. The unit operates at a speed of 1,500 rpm, and can also be obtained in models that run in other speeds such as 700,550 and 400 rpm. A supporting ring on the housing permits overhead suspension of the tool to relieve the operator. Airetool Manufacturing Co.

Circle E1 green card, last page

Structural Shapes for Industrial Models



A wide variety of plastic structural shapes for industrial model-builders have been added to a line of piping and pipe fittings.

The structural shapes are made of steel gray impact polystyrene and available in I's, H's, angles, channels and tees—sizes ranging from ⅛ to 1¼ inch. Users of industrial models may obtain standard plastic parts for structures, vessels and equipment, as well as a wide range of scale pipe and fittings in four colors. Industrial Models, Inc.

Circle E2 green card, last page

Chromatograph Controls Process Continuously

The use of a chromatograph and pneumatic controls for continuous process control has been demonstrated to engineers representing leading petroleum and chemical processors and engineering contracting companies.

Previously, the application of the flexible and comparatively low-cost chromatograph as the primary element for continuous process control was limited to monitoring because it is a batch-type instrument. However, a pneumatic control especially modified for the application stores "peak" values from the standard CEC Type 26-202 Process Chromatograph and uses these values as the basis for process control until the next peak value is supplied by the chromatograph.

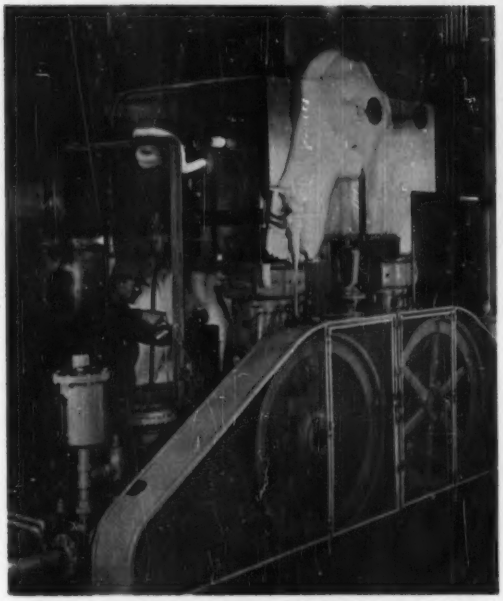
This type of stream analyzer can detect a deviation in final product purity and can take self-corrective steps to bring the process back in line. Four units make up the chromatography system for continuous process control. They are the Process Chromatograph, its control unit, the EMF-air transducer modified for peak memory storage, and its accompanying pneumatic recorder-controller-receiver.

The pneumatic controls include a potentiometer transducer to convert millivolt output of the chromatograph to pneumatic output and modified with memory storage to retain the value of selected peaks, and a pneumatic recorder-controller to record chromatogram peaks and to control by stroking a valve directly or resetting the control point of another controller that operates the valve, depending on the dynamics of the process.

The chromatograph analyzer determines the components in a sample by measuring the time it takes each component to go through a column and reach a detecting device. As each fraction emerges, it makes a peak. The position of the peak on the chromatogram indicates the time required to pass through the column and its amplitude represents the concentration of the component.

A control unit for the chromatograph programs the entry of the sample into the analyzer, and removes heavy components to reduce the cycle

EXPANSION ENGINES TO PRODUCE LIQUID HELIUM AT MINUS 452 F



↑ Vertical single cylinder expansion engines on helium separation service. Hydraulic power absorption system permits quick and accurate response to flow changes.

To build a machine to operate at temperatures just 7.4 degrees above absolute zero requires skill and experience. Temperatures below—400 F are not new to Worthington. Worthington has already engineered expansion engines to operate at—422 F. Worthington has completed extensive engineering work to meet the operational problems encountered at the liquefaction temperature of helium.

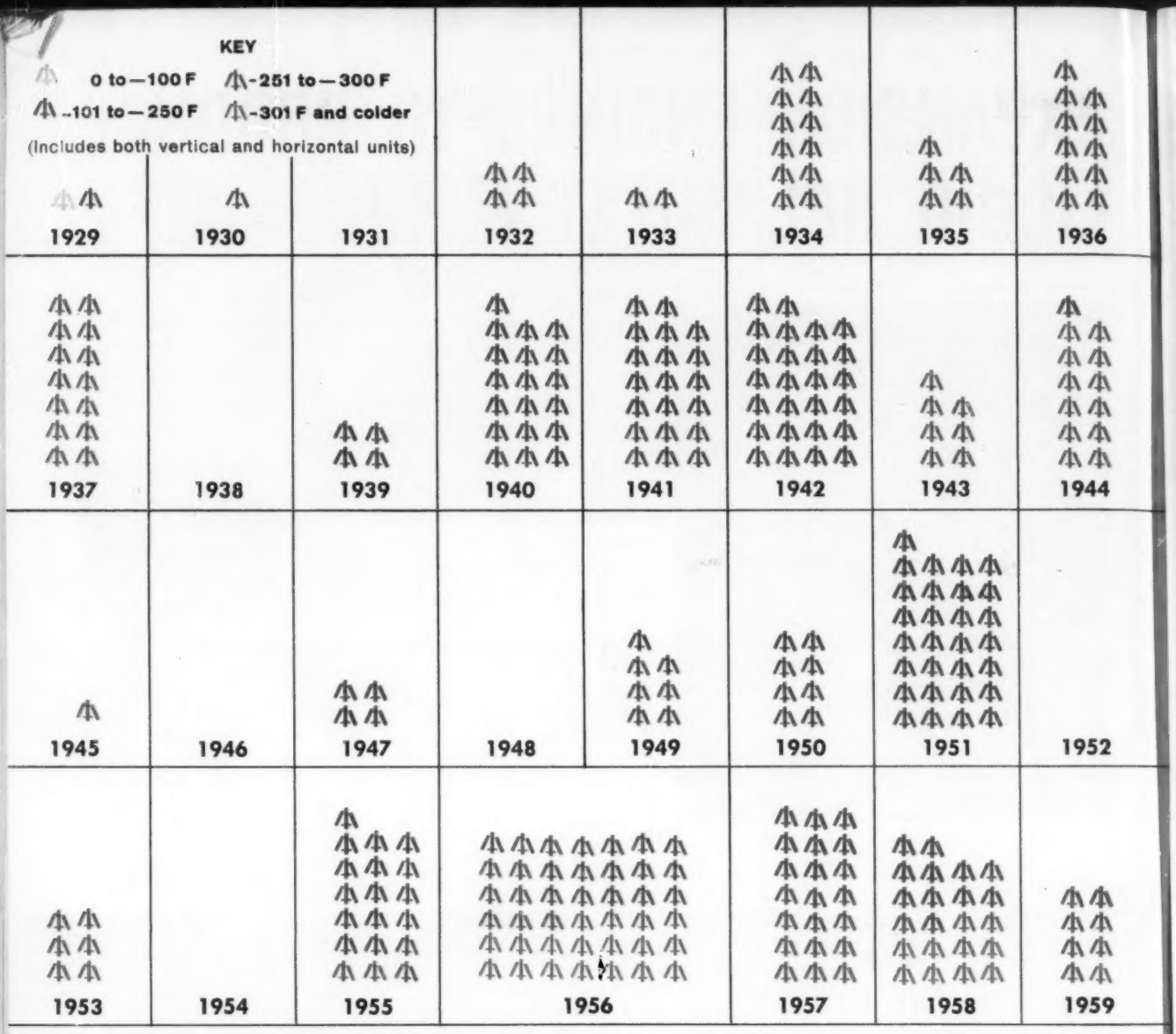
As a natural result of this low temperature work, Worthington now offers reciprocating expansion engine for the demanding job of helium liquefaction. For a documentation of Worthington's experience in the expander field, please turn the page.

WORTHINGTON

Typical applications for Worthington expanders

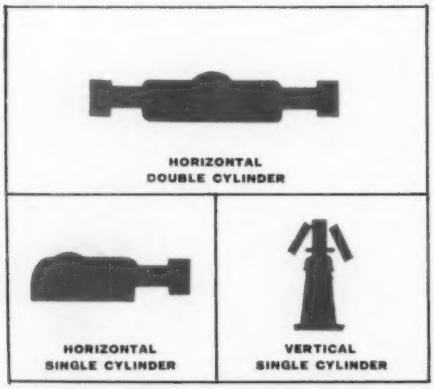
GAS	LIQUEFACTION TEMPERATURE (Atmospheric Pressure)		
	Fahrenheit	Centigrade	Kelvin
METHANE	−258.5	−161.4	111.7
OXYGEN	−297.4	−183.0	90.1
AIR	−317.6	−194.2	78.9
NITROGEN	−320.4	−195.8	77.3
HYDROGEN	−422.9	−252.7	20.4
HELIUM	−452.0	−268.9	4.2

↓ Horizontal single cylinder expansion engine on air separation service. Powerful frame and tough, yet precision valve mechanisms assure high engine reliability.



30 years and 307 expanders later...

WORTHINGTON IS THE WORLD'S LARGEST BUILDER OF LOW-TEMPERATURE RECIPROCATING EXPANSION ENGINES



3 basic designs to choose from

The illustration above pictures Worthington's broad range of experience in the low-temperature reciprocating expander field. (Supplementing this is Worthington's long experience in high and low-temperature turbine expanders.)

An expansion engine is not just a reverse compressor. It must have a powerful frame to handle pressures of several thousand lbs. per sq. in. The valve gear also requires special consideration. Several years ago Worthington developed a patented valve gear with remarkable durability. Operating under loads which sometimes exceed several tons, valve gear failures are almost non-existent.

Many expander applications call for non-lubricated construction. Worthington has successfully built many such units. Worthington also makes all types of units, in both horizontal and vertical designs, to handle every expander application.

Want more information? Send for your copy of a new 8 page expander bulletin. Write to: Worthington Corporation, Section 36-6, Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ont.

WORTHINGTON

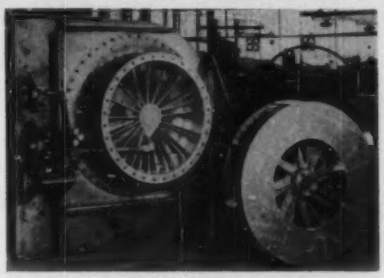
Equipment . . .

time. The analyzer, which has an explosion-proof housing, can be located in the processing area. The controller can be located remotely on a control panel, as can the pneumatic control instruments. Consolidated Electrodynamics Corp.

Circle E3 green card, last page

Gas-Tight, Spark-Resistant Fan For Solvent Recovery

A new gas-tight and spark-resistant fan for solvent recovery application in the petrochemical industry has just been manufactured. The entire fan unit is de-



signed and built to minimize the possibility of an explosion when handling the highly volatile solvent vapors.

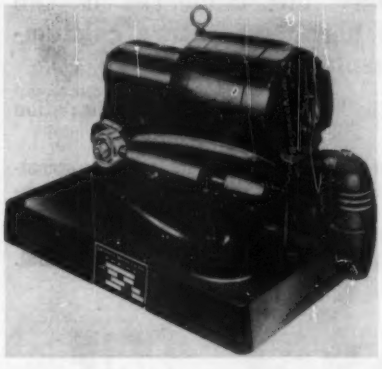
Basically, the new unit is a type HE fan with a radial blade wheel. The 50-inch diameter wheel is fabricated of aluminum and has a cast manganese-bronze spider. Variable inlet vane control is provided for automatic volume regulation; this accessory is also of gas-tight construction. The inlet vanes are automatically operated by means of an air motor. An emergency manual control is also provided (see photo).

The solvent recovery fan is rated at 200 bhp and delivers 19,000 cfm at 1780 rpm, 100° F and 42.5-inch wg static pressure. American-Standard.

Circle E4 green card, last page

Proportioning Pump Has Accuracy Of ± 1 Percent

New 200 Series controlled-capacity pumps, which have a repetitive metering accuracy of ± 1 percent are available.



Simplex pumps have a capacity of 812 gph and Duplex pumps have double this

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THERE'S A REASON why more and more Motorpumps are being specified today in all types of industry:

Only the Ingersoll-Rand Motorpump combines proven features with modern design engineering that provide rugged dependability, highest pumping efficiency. Motorpumps give you ease of installation, low cost operation and minimum maintenance.

To meet your particular requirements, Motorpumps are available in the widest range of sizes and types. Capacities go from 5 to 2800 gallons per minute; heads to 650 feet. Write today for the latest bulletin.

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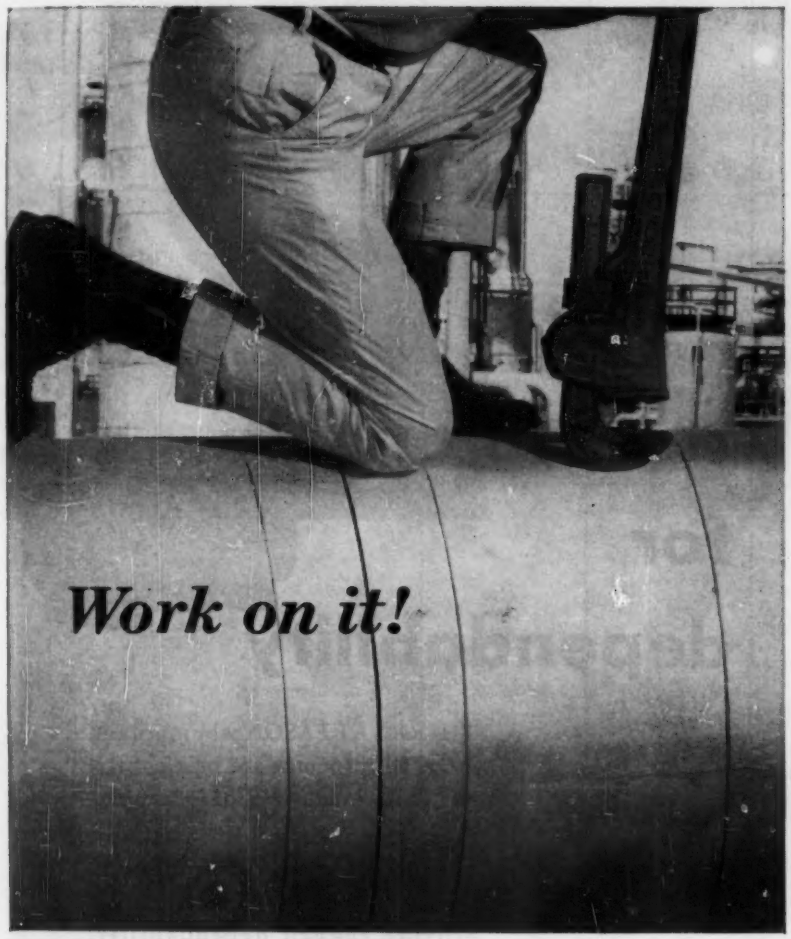
MOTORPUMP

From ¼ hp to 75 hp

For more data on advertised products, use Readers' Service Cards, last page.



J-M's new Metal-On® insulation is Thermobestos prejacketed in aluminum. Snaps on pipe quickly . . . surely. Saves the time and cost of separate on-the-job metal application.

Seminars on best installation practices. For plant foremen who wish to keep up to date on new insulation methods and installation practices, J-M regional sales offices will gladly conduct insulation seminars. Contact nearest J-M office.

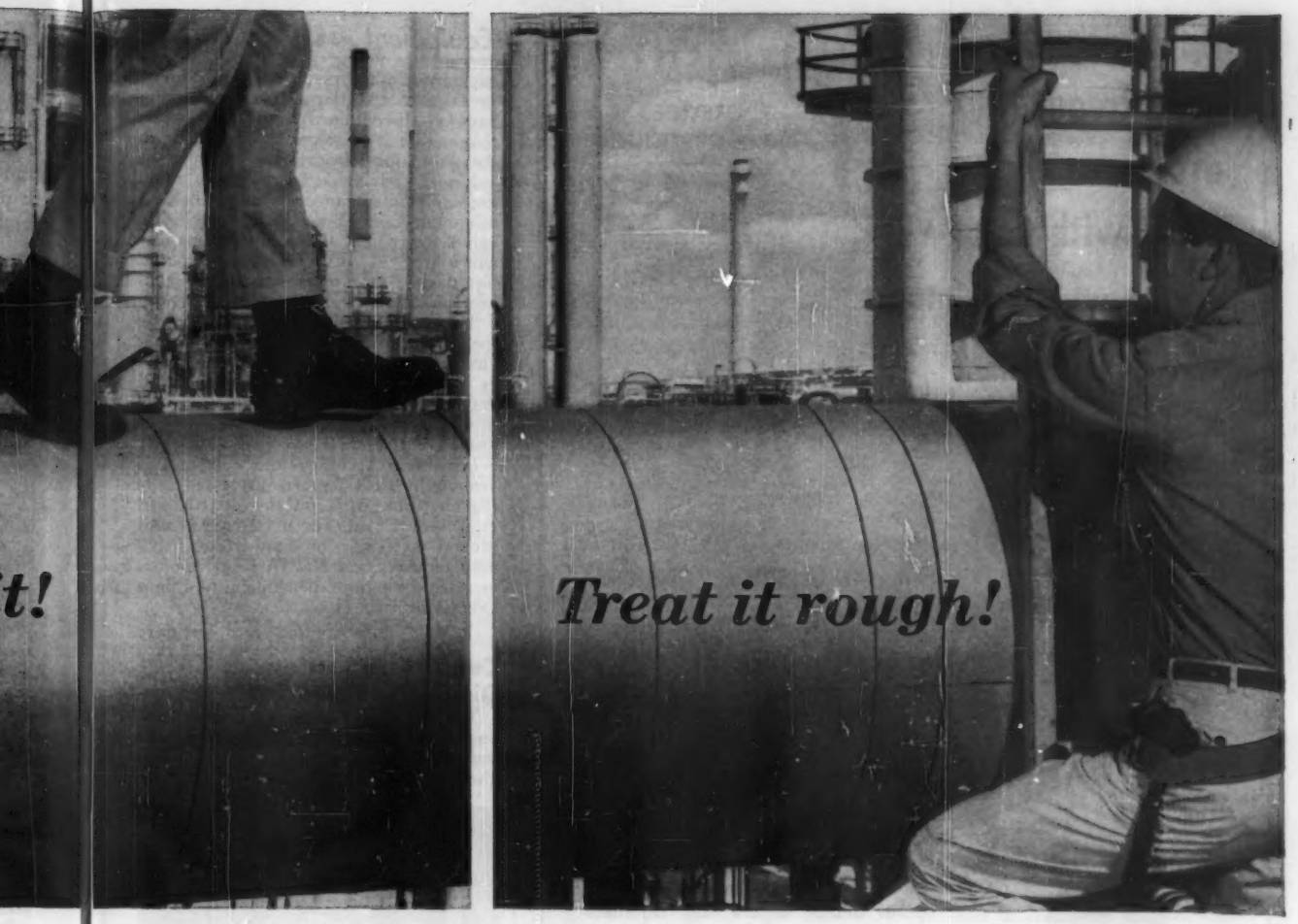
It's tough, durable Johns-Manville

Here's why Thermobestos is the preferred high-temperature calcium-silicate insulation . . . to 1200 F

You know the kind of treatment pipe insulation must take . . . day after day, year after year!

There's no better reason than this for the spiraling growth in Thermobestos® applications throughout the process and power generation industries —an insulation so strong and rigid, so resistant to crushing and compression it is almost structural.

For more data on advertised products, use Readers' Service Cards, last page.



THERMOBESTOS insulation!

Equally important is the ability of Thermobestos to keep fuel costs low. Its *k* factor is the lowest of all insulations generally accepted for process applications. Its moisture resistance, unsurpassed.

Furnished in large, lightweight sections—precision-molded to unusually close tolerances—Thermobestos is easy to handle and install . . . readily adaptable to shop fabrication of fittings and bonds. Large selection of sizes, thicknesses (and quads up to 33″ pipe size) permit calcium-silicate installations that are entirely Thermobestos insulation.

You'll want the new Thermobestos booklet for your technical file. It contains complete information on prefabricating and installation practices . . . specification data . . . heat transmission tables . . . and physical and thermal characteristics. Write for it today. Ask for booklet IN-169A. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, 565 Lakeshore Rd. East, Port Credit, Ontario.

JOHNS-MANVILLE PRODUCTS

JOHNS-MANVILLE

For more data on advertised products, use Readers' Service Cards, last page.

How frequently are you faced with these ••• corrosion problems with valves in your operation?

- ☒ CREVICE CORROSION
- ☒ PITTING CORROSION
- ☒ STRESS CORROSION
- ☒ INTERGRANULAR CORROSION
- ☒ UNIFORM CORROSION

Common problems . . . ? Exceptional problem . . . ? Which is it in your operation? Regardless of its nature, either common or uncommon, PACIFIC can help you bodyguard your operation against such corrosive elements with the proper selection of materials in valves of sound engineering principle and design.

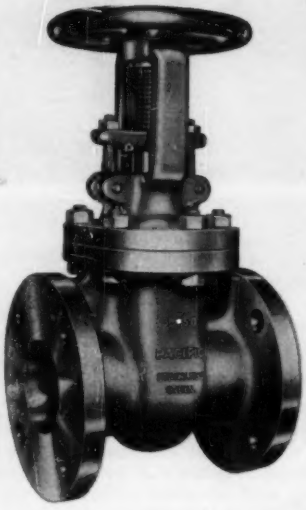


Figure Number 8550

Take for instance PACIFIC'S popular Figure Number 8550. Proper selection of material lends to its uninterrupted trouble-free performance. Lightweight pattern reflects sound engineering principle, providing maximum valve efficiency at a low initial cost! Heavy double discs, ball and socket design, ensure seat tightness and reduces hazard of galling. Tight fitting gasket joints prevent crevice corrosion on bonnet flange faces. Liberal internal areas reduce turbulence erosion of the body sections. You will find many uses for PACIFIC'S complete line of corrosion resistant valves in your operation . . . in steam, water, oil, gas, air, and numerous other types of corrosive services. For each application there is an economical solution . . . For each application there is a PACIFIC valve to do the job more efficiently-longer.

Write for corrosion resistant valves brochure.

PACIFIC VALVES, INC.

3201 Walnut Ave., Long Beach, California

Subsidiaries: PACIFIC SOUTHERN FOUNDRIES, INC. - Bakersfield, California
PACIFIC FORGE, INC. - Fontana, California
PACIFIC PATTERNS, INC. - Paramount, California

Sales offices in most principle cities.

Equipment . . .

capacity. Both types provide maximum pressure of 10,000 psi. The new pumps have a self-contained lubricating system that makes it unnecessary to shut down the pump for lubrication.

Liquid ends made from various alloys are easily interchangeable in the field at minimum cost. E-Z Clean cartridge valves simplify and minimize maintenance operations. With this type of liquid end, it is unnecessary to disconnect piping to clean or inspect valves.

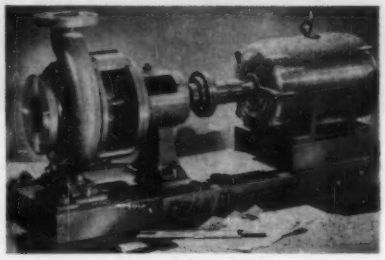
These controlled capacity pumps move specific volumes of fluid, including "tough," corrosive materials, into high or low pressure systems in virtually all desired ratios, with flow, temperature, pressure, conductivity, pH and other process variables.

Long-term accuracy and economy is assured by such features as sealed self-aligning bearings on the crank and crosshead. Crossheads of hardened and ground steel ride on cast iron. Heavy duty reducers and NEMA frame motors increase the pumps' dependability. Pump Div., American Meter Co.

Circle E5 green card, last page

Centerline Suction And Discharge Featured In Pump

The new "pH" pump features a centerline suction and discharge making installation simple and inexpensive. It can also be easily dismantled for servicing



without disturbing either suction or discharge piping. Maximum changeability of parts makes it possible to change the capacity of a pump merely by changing the casing and impeller. This feature reduces costs of maintenance and spare parts inventory.

The new high alloy pump, which is designed to the requirements of fully accepted and established industry codes and specifications, offers quality and performance at the lowest cost. Dean Brothers Pump, Inc.

Circle E6 green card, last page

Antioxidant Is Effective At Low Concentrations

A new general purpose, ashless antioxidant based on a mixture of aryl amines now is available for use in greases, turbine and crankcase oils, and ester lubricants.

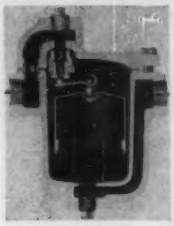
To be marketed as "Ortholeum" 302 antioxidant, the compound when used as a stabilizer in synthetic lubricants, effectively inhibits viscosity change, copper corrosion, and acid-number increase in high-temperature oxidation tests. In

automobile engine and laboratory bench tests, the new product reduces bearing corrosion, oxidation, and acid formation in mineral and synthetic oils as well as greases.

"Ortholeum" 302 antioxidant generally is effective at low concentrations. E. I. du Pont de Nemours & Co., Inc.

Circle E7 green card, last page

Double Fulcrum Type Bucket Trap Line Expanded



A series of new inverted bucket traps to expand the company's patented Duo-Step Leverage line, have been developed.

Production has begun on the design changes which provide horizontal connections ranging from ½ to 1¼ inch ips. The new traps feature high pressure cast iron (ASTM Class 35) construction. Pressures range to 250 psi and temperatures to 450° F.

Duo-Step Leverage, a patented double-fulcrum leverage principle, provides extra large drainage capacities while holding physical trap size to a minimum. The Clark Manufacturing Co.

Circle E8 green card, last page

Condensed Price Book On Motor Controls Available

A new digest with descriptive, pricing, technical and engineering information on a complete line of motor controls has been prepared.

A quick reference selector guide at the front of the digest makes it easy to find any starter, controller or pilot device in the book. This condensed version of the company's electrical control price book, its pages numbered in large bold type for easy reading in cross reference with the price book numbers at the bottom of each page. Allis-Chalmers Mfg. Co.

Circle E9 green card, last page

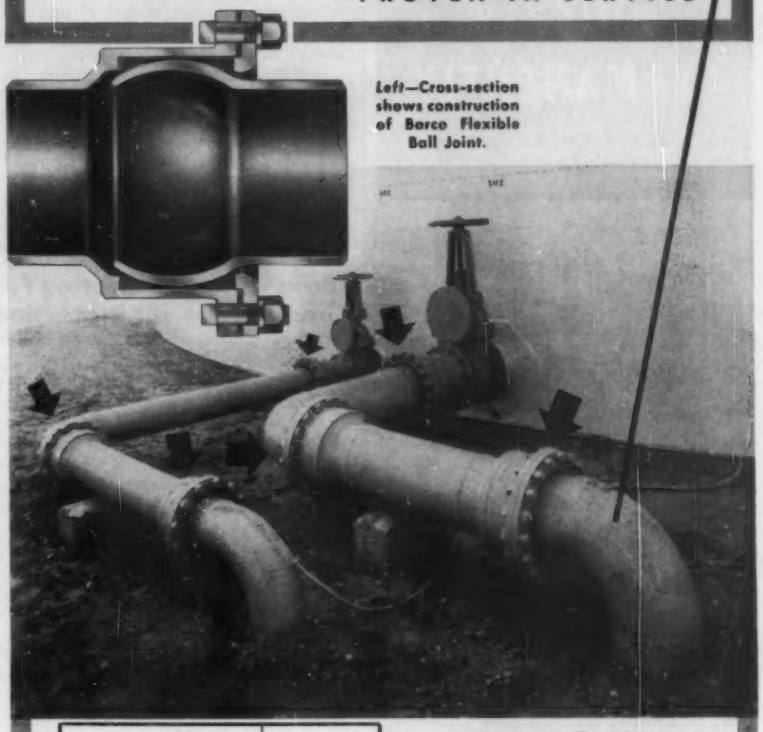
Plug Valve Operator Is Also Automatic Lubricator

Roto Hammer is a self-contained mechanical operator, free of pneumatic or electrical power, designed to not over-lubricate valves but allow additional lubrication if desired by the operator. It provides a ground level control for remote operation of overhead plug valves, eliminating many expensive and hazardous platforms.

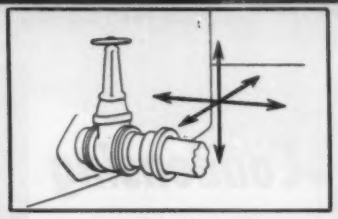
The unit saves on initial installation costs by enabling valves in overhead lines to be installed in straight runs, thus eliminating the need for routing piping to ground level or providing a platform. It makes possible hand operation of such overhead valves at ground level. Ade-

Unlimited Flexibility!

—PROVEN IN SERVICE



Left—Cross-section shows construction of Barco Flexible Ball Joint.



Allows 6-Way Movement!

Freedom of movement in any direction is readily possible with these *ball joint connections* of 12" pipe (right) and 8" pipe (left) to 80,203 bbl. tank shown in above photo. (Photo: SHELL OIL COMPANY, Dominguez Refinery, Wilmington, Calif.)

Barco Ball Joints—*Fire Safe!*

provide complete protection against FIRE, PIPE EXPANSION, TANK SETTLING

Major oil companies throughout the country now approve the use of Barco's new large size Flexible Ball Joints on tank connections for the following reasons:

1. **Fire-safe. The joints have passed rigid fire and water spray tests.**
2. **Superior for handling pipe expansion—no combustible packing, no thin wall sections, no "end thrust" from pressure, no heavy pipe anchoring required.**
3. **Complete protection—relieve strain and twisting forces on valve flanges or tank wall.**
4. **Compact! Ideal for use inside narrow space between fire wall and tank. Easy to design piping for any amount of flexibility desired.**
5. **Also useful for insulating piping against electrolysis.**
6. **Long service life without maintenance. No lubrication. Sizes to 16"; flanged or welding ends.**

For engineering recommendations, see your nearest Barco representative or write. ASK FOR CATALOG 215B and BULLETIN 31-A.

PRODUCTS BACKED BY EXPERIENCE BARCO FOUNDED 1903

BARCO MANUFACTURING CO.

542N Hough Street • Barrington, Illinois

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

In Canada: The Holden Co., Ltd., Montreal

REPAIR PIPE LEAKS
QUICKLY
PERMANENTLY
ANY PRESSURE
ANY TEMPERATURE

SKINNER-SEAL
EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

SKINNER-SEAL
COLLAR LEAK CLAMPS—for oil and gas lines. Gasket is sealed by gasket container rings—pressure is sealed in . . . air, moisture and gasket-destroying soil conditions are sealed out. Effective under any pressure. Sizes 2"—13" O.D. incl. In stock at oil supply stores!

For over half a century, a complete line of Repair Clamps and Saddles for steel and cast iron pipe. Send for catalog!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

Equipment . . .

quate lubrication before each valve operation greatly extends the life of the valve, plus saving the cost of down time while the valve is being changed and always assures a free operating valve.

Refilling the grease reservoir in a Roto Hammer plug valve operator in overhead service is simpler than greasing the stem of a gate valve or changing a light bulb in overhead service. The unit is also offered as a hand operator for valves at ground level. Roto Hammer Co.

Circle E10 green card, last page

Epoxy-Bitumen Coating For Cheap One-Coat Protection

A new, low-cost epoxy resin-bitumen coating especially suited for use as an economical corrosion-resistant coating for pipe and other metal equipment and on concrete surfaces has been developed.

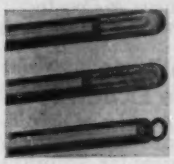
The new coating, based on EPON 828 and Bitumen C, a compatibilized bitumen, has greater chemical resistance than existing epoxy-coal tar enamels. Two-month immersion tests showed it to be unaffected by many acids and other corrosive materials.

This high solids coating is outstanding as a one-coat, inexpensive maintenance coating. It is suggested for use on the inside and outside of pipe and for service in any area subject to corrosive chemical fumes and spillage. Shell Chemical Corp.

Circle E11 green card, last page

Thermocouple Wire Can Be Bent To Very Small Radius

A new line of mineral insulated thermocouples provides flexibility that permits bending into unlimited configurations; high temperature range up to 3,000° F; small-size probes from 0.040 inch to 0.375 inch O.D. diameter sheath; fast response rate which is practically instantaneous; long life with thermocouple wires encased by inert minerals in air tight chamber; shock and vibration proof; and corrosion resistance from a wide choice of sheath metals.



Con-O-Clad with two thermocouple wires is available from stock in 0.062 inch, 0.125 inch, 0.187 inch and 0.250 inch diameter sheath. Semi-standard 0.040 inch and 0.375 inch diameters also available as well as single and multiple thermocouple wire.

Sheaths of Type 304 Stainless Steel and Inconel are standard stocked materials. Types 310, 316, 321, and 347 Stainless Steel, Monel, Titanium, Tantalum, Aluminum, Copper and Platinum sheaths are also available.

Insulation of Magnesium Oxide, Aluminum Oxide or Zirconium Oxide are standard. Minimum insulation resistance wire-to-wire or wire-to-sheath is 1.5 maghoms at 500 volts DC in sizes 0.062 inch diameter and larger for lengths up to 30 feet. Con-O-Clad may be bent to

Condensing Gasoline for H. L. HUNT

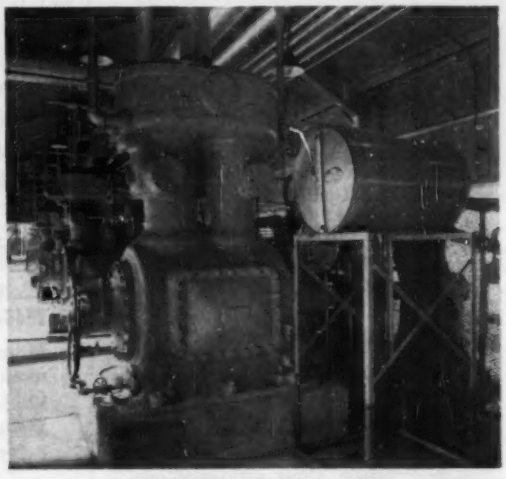


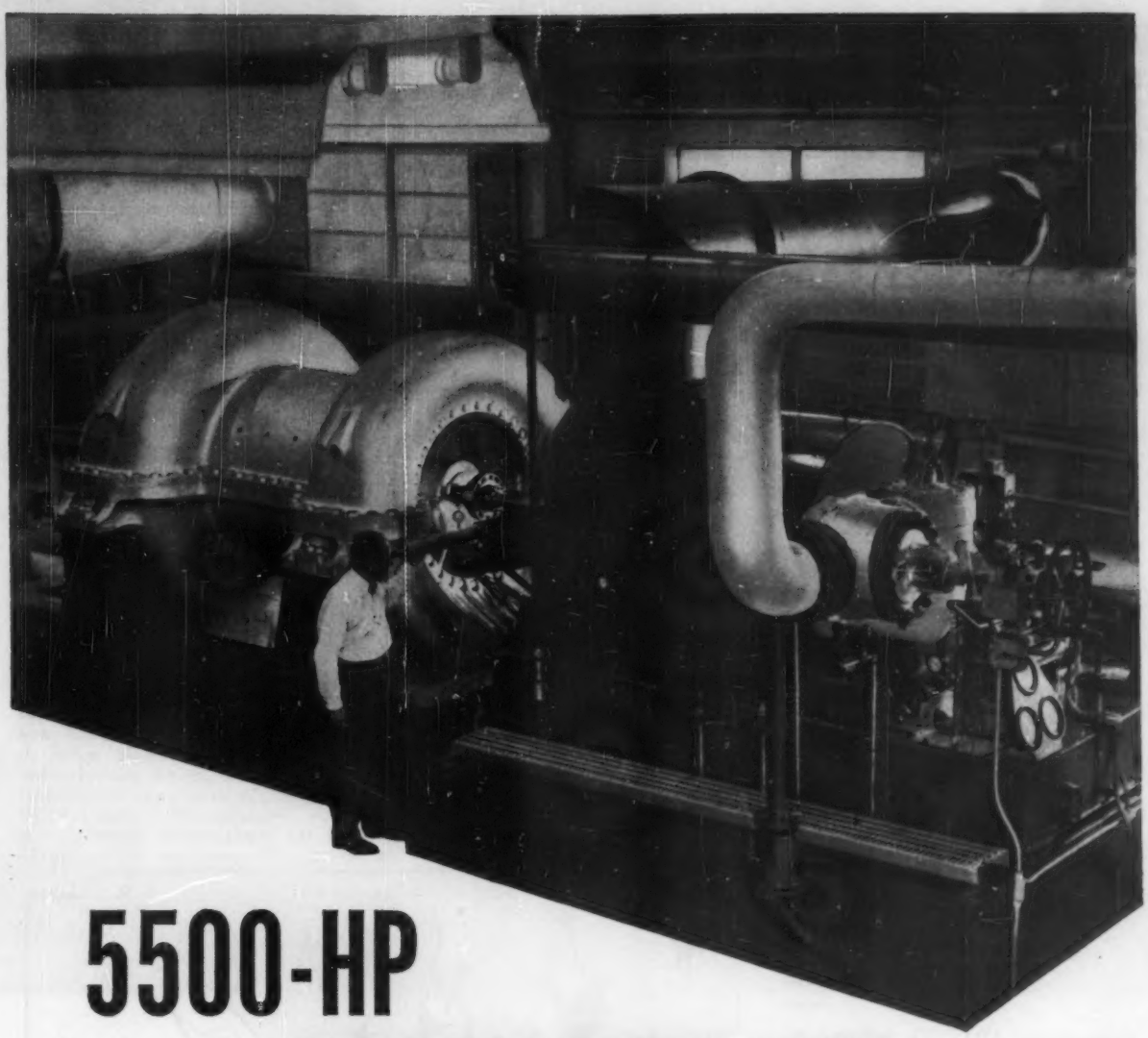
PHOTO BY OIL & GAS JOURNAL

H. L. HUNT, Allen Parish, La., operates four Frick 12" by 12" ammonia compressors, plus a 10" by 10" and numerous shell vessels, in a 10 MMCFD refrigeration oil absorption type natural gasoline plant.

Temperatures range down to −10° F. These compressors were furnished by Kay Engineering Co., Frick distributors at Oklahoma City, Dallas and Houston.

For all types of process cooling, air conditioning, ice making, quick freezing or other industrial cooling, you too can depend on Frick equipment for economical and dependable operation.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA., U. S. A.



5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

TERRY

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TT-1215

For more data on advertised products, use Readers' Service Cards, last page.

A Vital Feature...

LOWER PRESSURE DROPS

with

ARLCITE

CATALYST BED SUPPORTS

Super-strong ARLCITE Spheres insure minimum pressure drops in product flow through catalyst bed supports. Of special high-density alumina-ceramic composition, Arlcite Spheres have high compressive strength combined with extreme resistance to thermal shock.

Repeated temperature cycling, years of service will not cause Arlcite to crumble, split or chip. The interstices between the balls thus remain free of fines to maintain a constant low pressure drop. Investigate the economy of ARLCITE Spheres in *your* catalytic refining process. Write!

PORCELAIN DIVISION
FERRO CORPORATION
East Liverpool, Ohio

Equipment . . .

a radius of twice the sheath diameter on the centerline.

Iron-Constantan, Copper-Constantan or Chronel-Alumel are the standard thermocouple calibrations in Con-O-Clad. Platinum/Platinum-10 percent Rhodium and Platinum/Platinum-13 percent Rhodium calibrations are also available. All Con-O-Clad is color coded for type of sheath metal and calibration of thermocouples.

A choice of three standard types of hot junctions are available. Type "U" (Ungrounded) butt-welded hot junction is completely embedded in densely compact mineral insulation with sheath material unalloyed at tip which maintains original corrosion resistant properties. Tightly packed at tip (no voids) and inert gas welding provides long life under maximum vibration, shock, and corrosive conditions. In addition, electrical resistance tests to check thermocouple continuity may be easily made without removal from system (see top cross-section). Type "G" (Grounded) hot junction is welded to tip of sheath and is adequate for many applications except in extreme high temperatures and corrosive atmospheres (middle cross-section). Type "B" (Bare Wire) hot junction is butt welded providing minimum mass and maximum response rate (bottom figure). Exposed mineral insulation is completely sealed with silicone compound against liquid or gas penetration. Conax Corp.

Circle E12 green card, last page

Catalog Shows Complete Industrial Control Line

Combining information from several other catalogs to present a comprehensive line, the new Industrial Controls Catalog lists many well-known products, including automatic temperature, pressure, level and flow controls, as well as counters, switches and automation controls.

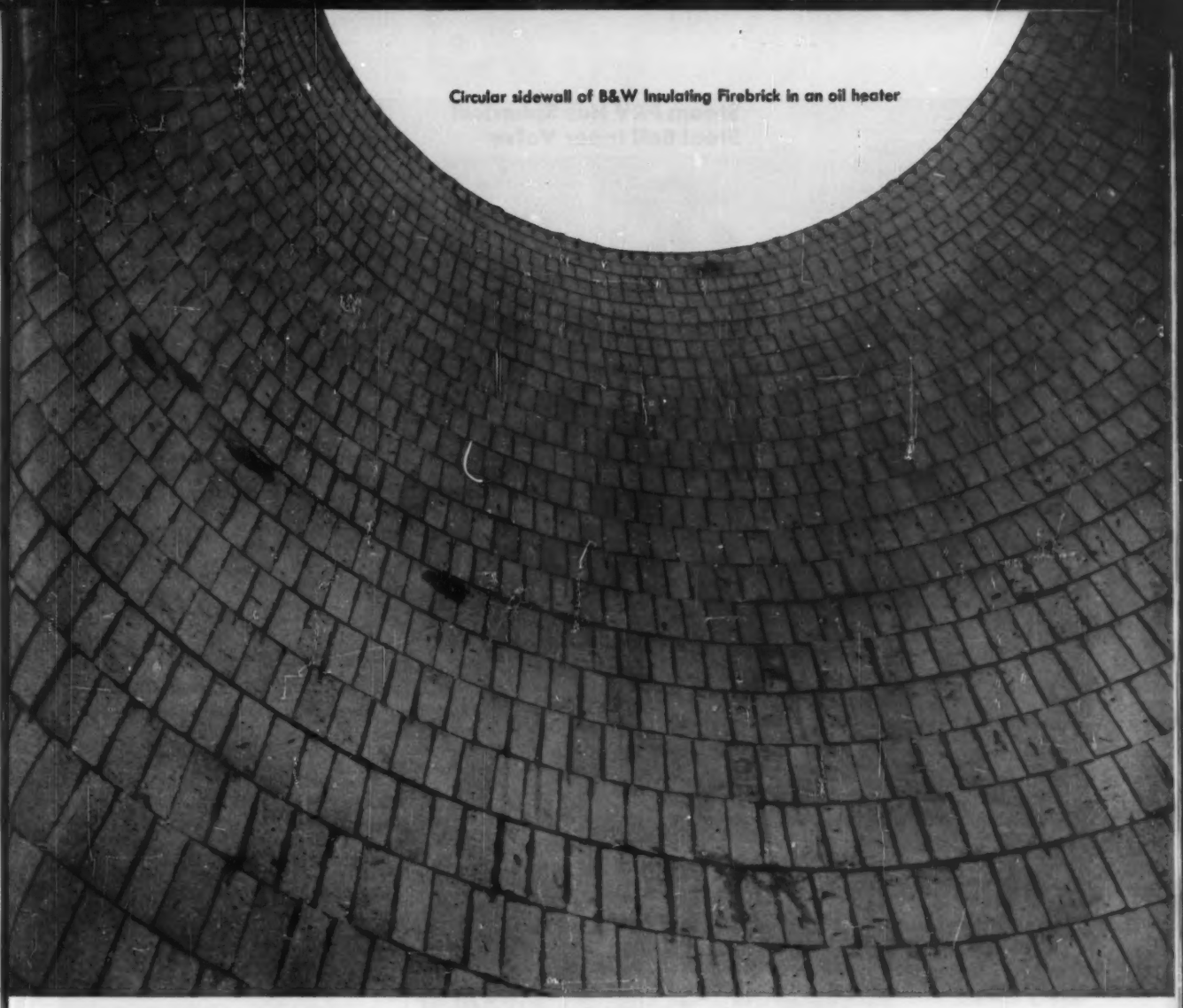
Other items illustrated and described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators. There is also a section presenting the famous "Hydramotors," electro-hydraulic actuators having many patterns, designs and valve body materials. General Controls Co.

Circle E13 green card, last page

Remote Shut-Off Regulator Operated by Solenoid Valve

Solenoid actuated regulators for on-off control are available. They are widely used in industry wherever remote shut-off, remote start-up, automatic safety shut-off, and combination pressure and temperature control with an electric signal are needed. When the solenoid opens, it allows steam to enter the pilot chamber and operate the main valve as a normal pressure regulator. When the solenoid closes, the steam supply to the pilot is

Seasons Greetings
We take time out to express our thanks and good wishes to all
MERRY CHRISTMAS and a HAPPY NEW YEAR
CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA



Circular sidewall of B&W Insulating Firebrick in an oil heater

How B&W Insulating Firebrick cut processing costs

Here are four *key* reasons why B&W Insulating Firebrick reduce over-all costs in chemical and petroleum process furnaces:

High Hot Load Strength —B&W IFB provide maximum load-bearing capacity *under operating temperatures.* Many oil heaters have been built with walls 80 feet high *with no intermediate support.*

Low Heat Storage — Cost-cutting B&W IFB have the *lowest* heat storage of any insulating firebrick. Since B&W IFB cool off fast, they protect expensive alloy tubes in the event of forced shut-down . . . make possible quick access to the furnace for inspection. They also reach operating temperature quickly, reducing cycle time and fuel bills.

Long Life — B&W Insulating Firebrick are *long* lasting because of the exceptional refractory nature of their base ingredients and the high processing temperatures to which they are subjected during manufacturing.

Short Installation Time —You save materially with B&W Insulating Firebrick because they are machined to size. They may be modified to fit door openings, peepholes, and other special conditions because they can be cut, drilled or shaped on the job with ordinary woodworking tools.

These sound reasons explain why process furnace builders and operators specify B&W Insulating Firebrick. Learn how these lightweight brick can help you save money. Your B&W representative will be glad to give you facts and figures.

BABCOCK & WILCOX

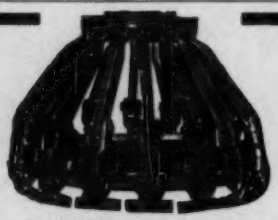
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

B&W REFRACTORIES PRODUCTS:
B&W Alumul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

R-916

Equipment . . .

shut off and the main valve closes automatically. Available in ductile iron ½-3 inch, bronze ½-2 inch, and cast iron 2½-3 inch, the regulators are suitable for maximum temperatures of 500° F and pressures of 250 psi. The ½-2 inch No. 1163 Series has screwed ends and the 2½-3 inch No. 1163-F Series has flanged ends. Packless construction, silent operation, freedom from wire drawing and positive tight shut-off are featured. OPW-Jordan. **Circle E14 green card, last page**



BARRETT automatic
Filling and Crimping Equipment
for handling greases and other viscous fluids.
- No operator required.
- 100% air operated.

Fills, seals, stamps and counts lug cover pails. Output of 15 pails per minute. Write for details on installation to meet your requirements.

BARRETT
Manufacturing Co.
P. O. Box 8096, Houston 4, Texas

Steam PRV Has Spherical Steel Ball Inner Valve

A new, external pilot-operated steam pressure reducing valve has just been announced. It is called No. KP-4, and it meets all requirements for use at most steam pressure reducing valve installations.

Although extremely sensitive, its simple operation insures trouble-free service. Pressure adjustments are quickly and easily made by turning the adjusting screw on the pilot valve. It will close tightly for dead-end service.

The outstanding features of the new valve include an AISI type 440C stainless steel ball inner valve, perfectly spherical and extremely hard, which closes against a monel seat ring. This combination will withstand the wire-drawing effects of steam indefinitely. The tapered form of the opening between the ball inner valve and beveled seat ring increases the valve capacity by streamlining the flow of steam.

The large main valve diaphragm is made of stainless steel to permit use with higher pressures and temperatures. The control spring is located entirely outside of the path of steam flow. Klipfel Valves, Inc.

Circle E15 green card, last page

Epoxy Repair Kit Requires No Special Tools Or Skill

After more than five years of highly successful use by many leading oil companies Epi-SEAL epoxy resins are being offered in a compact, economical and easy-to-use oil repair kit. The versatile repair kit is recommended for a wide variety of repairs including: cracked welds on pontoons for floating roofs, leaking seams and rivets on storage tanks, corroded areas in casing tubing and pipe, holes in tanks, fittings, valves, piping, faulty threads and welds as well as many leaks on oil transports and trucks.

Repairs can be made without "gas freeing" and no special tools or skill are necessary. The repair kit contains: epoxy resin, glass tapes, two types of reinforcers, stirrers, brushes, gloves, sandpaper, non-sparking wire brush, solvent as well as complete instructions for use—more than enough material to complete 12 different repair jobs. Bonded Products, Inc.

Circle E16 green card, last page

How Inhibitors Control Corrosion Told In Brochure

A new eight-page brochure on KONTOL corrosion inhibitors for petroleum refiners has been just made available.

Supplemented with schematic diagrams, detailed engineering drawings, and photographs, the application of corrosion inhibitors to various refinery systems is explained and evaluated.

The booklet describes how and why KONTOL is effective in correcting such problems as hydrogen blistering, and in supplementing pH control. Tretolite Co. Div., Petrolite Corp.

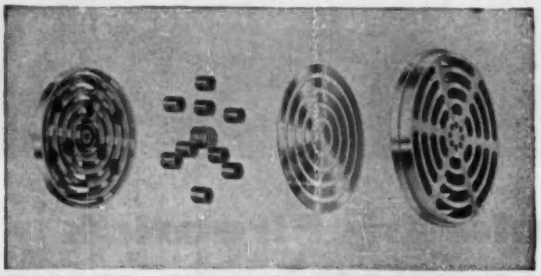
Circle E17 green card, last page

Epoxy Repair Kit Used For Emergency Onstream Patch

A new epoxy multi-use repair kit for making "on the spot" repairs has been released.

The Carbo Fix repair-kit is a two-component, fast-setting, epoxy material that cures to a hard, tough, tightly bonded patch, restoring the damaged or

VOSS VALVES in your machine mean



LESS MAINTENANCE, FEWER SHUTDOWNS for your compressor. (air, gas, ammonia)

- up to 40% more valve area • minimum pressure loss • higher efficiency
- less power consumption • normal discharge temperature
- quiet, vibration-free • utmost safety • lower operating costs

VOSS VALVES are made to specification, machined from solid stock (not cast)—using best alloy steels; for corrosion condition—stainless steels, such as 410, 18-8 or non-ferrous alloys—monel, inconel, etc. PLATES are machined (not stamped) and ground for precise close tolerance fit; are dimensionally stable . . . ductile . . . resist fracture, high temperatures and corrosion . . . withstand fatigue. SPRINGS of heavy rectangular sections and large diameters, add to dependability and safety.

Our detailed proposal will be sent without obligation. Send name, bore, stroke and speed of machine.

J. H. H. VOSS VALVES REG. U.S. PAT. OFF.
J. H. H. VOSS Co., Inc.
785 East 144th Street, New York 54, N. Y.

REFRACTORY HAYDITE
Makes Higher Heat Resistant Concrete

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
We sell direct to you.

CONSTRUCTION MATERIALS
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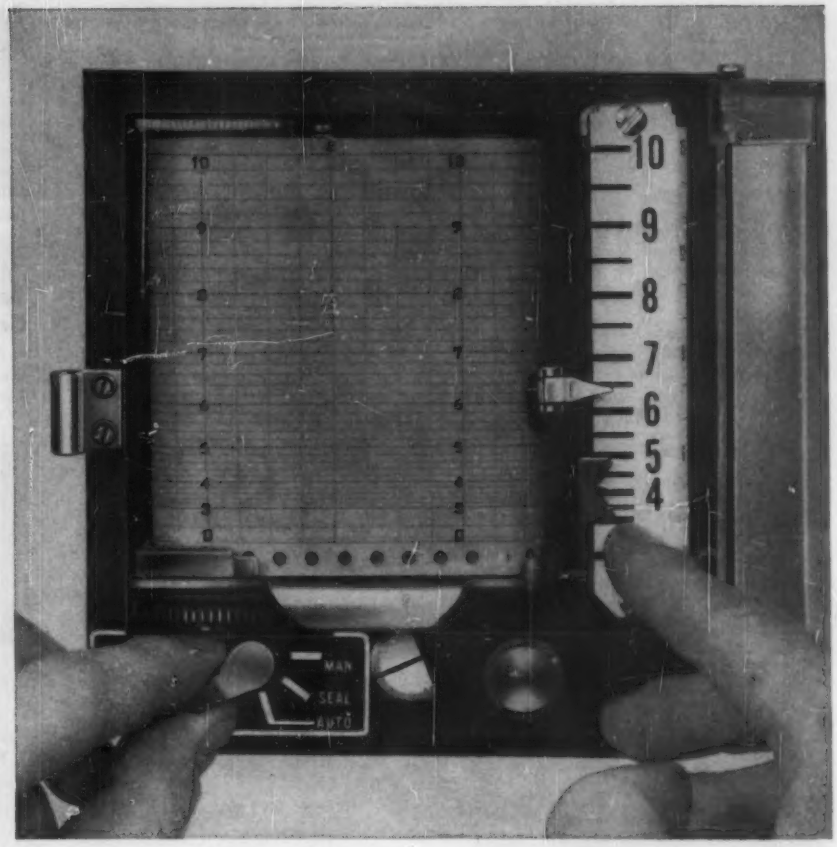
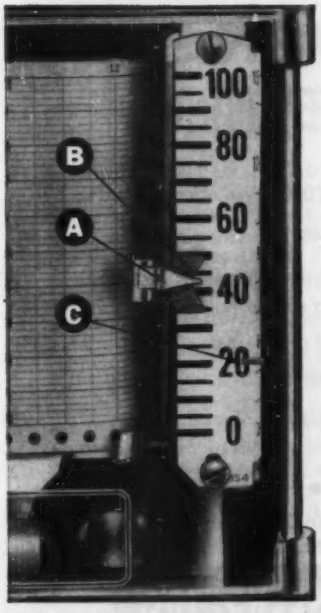


One of 38 Metagraphic Receiver Models you can choose from, all with only 5" x 5⅛" panel. This model has single-knob, six-position transfer station for completely "bumpless transfer" in cascaded control systems.

BRISTOL METAGRAPHIC RECEIVERS:

"Easiest 'bumpless transfer' you ever saw"



Variable (A), set point (B), and valve position (C), all on same scale, make manual-automatic transfer easy.

That's what instrument men say after trying the Bristol Metagraphic Pneumatic Receiver—even in cascade control systems.

Just seal, match pointers, transfer. There's not a single value to read. That's because the Metagraphic gives you valve position, set point and measured variable *—all on the same scale.*

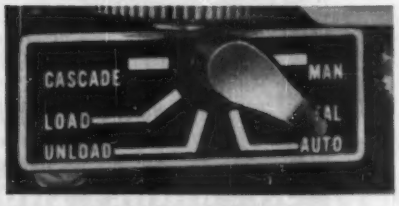
No finger-disconnects here! The Metagraphic is a true plug-in receiver—plugs and unplugs in 5 seconds with no loss of automatic control.

You can switch from indicator to recorder in less than 10 seconds, interchange many receiver models, change range simply by changing chart. Cuts down on costly reinstallations if process requirements are changed.

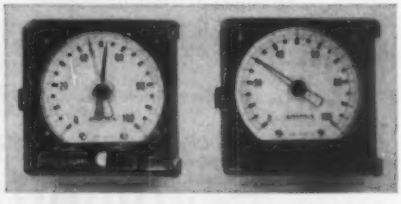
Write today for the complete Metagraphic story. Don't forget, Bristol offers the widest selection of miniatures on the market. (Full sized instruments, too.) The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. B-10

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Six-position transfer station (enlarged view) for cascade service. Three-position manual-automatic station is also available.



Metagraphic Indicating Receivers have full 9-inch scale for easy reading; feature complete 10-second interchangeability with recorders.

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Refinery customers have found that, in comparison with other inhibitors, Dalpac 4 (Hercules 2,6-di-tert-butyl-p-cresol) saves up to three dollars on every thousand barrels of gasoline produced. Dalpac 4 inhibits gum formation, stabilizes gasoline color, and helps maintain engine cleanliness. Refiners have also found it to be excellent in turbine and transformer oils where it prevents deterioration, and does not affect electrical properties.

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broken piece to its original condition.

Repairs can be made to equipment, pipes, tanks, valves, fixtures, machinery and many more plant items. Damage such as breaks, leaks, cracks and wear can be easily and quickly repaired.

Two types of repair kits are available. Carbo Fix S is a general repair material with good chemical resistance for repairs to most all surfaces, including glass. Carbo Fix C has excellent chemical resistance and is recommended where chemical attack is of major consideration.

Each kit contains a jar of resin and a jar of catalyst, fiberglas cloth, measuring spoons, stirring paddle and instruction booklet. Carboline Co.

Circle E18 green card, last page

Chromatograph Recorder Has Several New Features

A new Series 143X chromatography recorder is a strip-chart instrument with features designed especially for vapor phase chromatography recording. These features include continuous standardization, low-inertia pen carriage, high resolution slidewire and provision to add accessories such as a retransmitting slidewire, a manual chart speed changer, limit switches and recorder feet for portable use. Minneapolis-Honeywell Regulator Co.

Circle E19 green card, last page

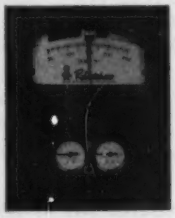
Folder Helps Designer Select Tube Fittings

A new four-page folder offers condensed information to help select proper tube fittings for various service and installation requirements. It includes shape charts for six types of industrial tube fittings and illustrations of tube-working tools. Parker-Hannifin Corp.

Circle E20 green card, last page

Temperature-Pressure Controller Easily Adjusted

An indicating pneumatic controller for temperature or pressure, offering for the first time a fully compensated thermal system as a standard feature, is available.



The unit, designed as a controller, transmitter or receiver-controller, combines features of dependable accuracy, ease of maintenance and simplicity of operation.

The device features a "clean" internal design, to facilitate servicing or changes of functions while in an installed position.

The new controller permits quick adjustment of the control point, proportional band, control action and reset

More clean water at a lower cost with...

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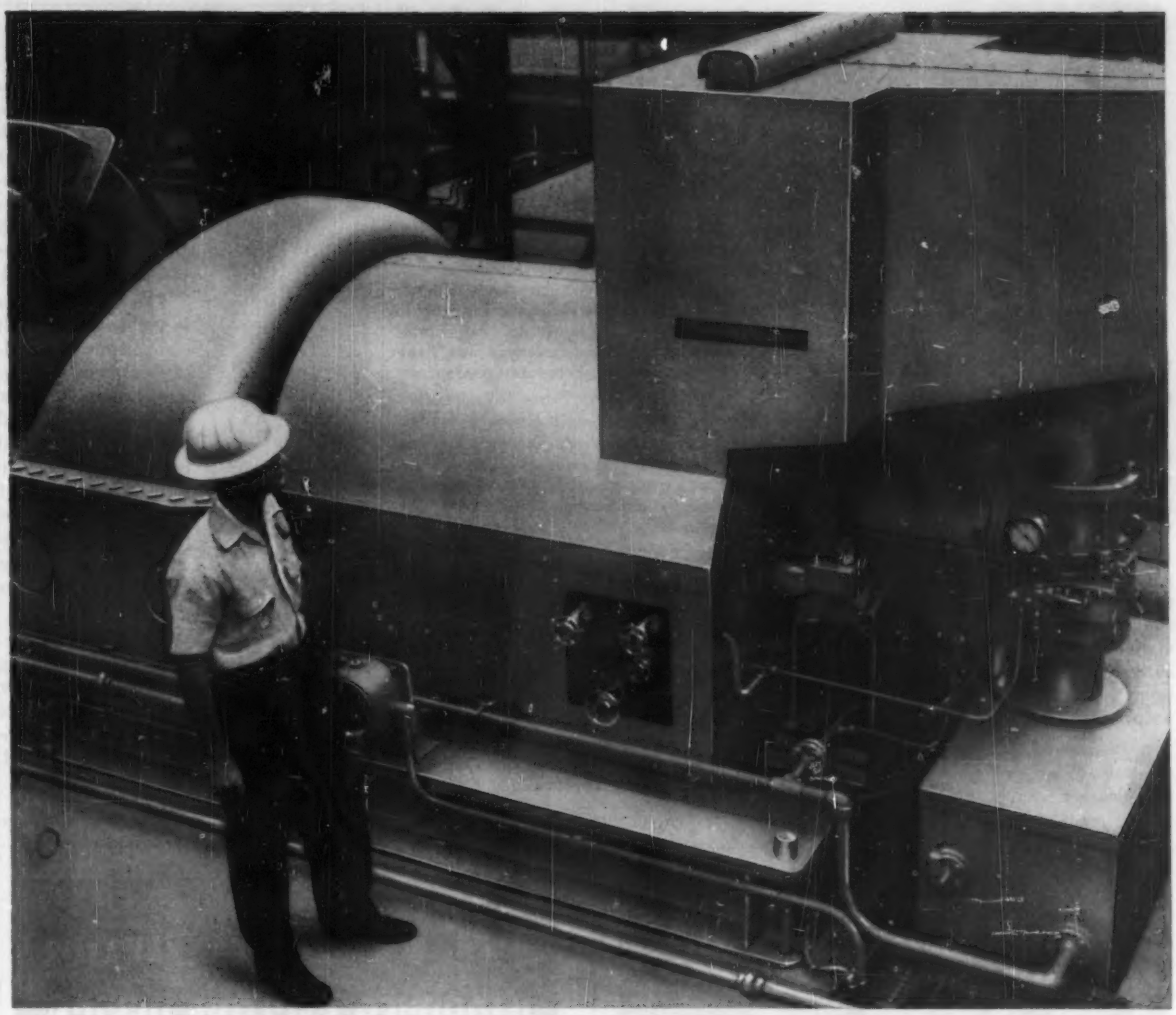

Westinghouse multi-stage, hi-speed turbines guarantee you

...engineered power to meet your exact needs

Why pay for power you can't use? Or, by the same token, why strain a machine beyond its capability? Westinghouse can meet your exact turbine requirements with the world's broadest line of wheel sizes and design capabilities for steam conditions through 2400 psig—1050° F at the throttle, exhausting from 1 in. hg absolute to 300 psig.*

Fitting the right wheel size to the job is the key to efficiency and economy. By knowing your process requirements, cost of steam and number of hours you expect your turbine to run during the "payoff" period, we can provide the turbine design best suited to your power and economic requirements.

To meet these varied requirements, Westinghouse has available five frame sizes of multi-stage, hi-speed turbines with wheel diameters ranging from 12 in. to 32 in. In addition, interchangeability of many wearing parts saves you money on inventories and stocking of spare parts.

Westinghouse turbine specialists located throughout the country are available at all times to provide personal attention to your heat balance problems, and are equipped to offer on-the-spot price and performance data for this entire turbine line. The capabilities of the world's largest and most modern small turbine facility are at your disposal. Call your Westinghouse representative, or write Westinghouse Electric Corporation, Small Turbine Sales, Lester Branch Post Office, Philadelphia 13, Pennsylvania. J-50605

***WESTINGHOUSE MULTI-STAGE, MULTI-VALVE, HI-SPEED TURBINE FRAME CAPABILITIES**

Turbine Frame	M-12	M-16	M-20	M-25	M-32
Number of Stages	.....	.....	As Required	.....	.....
Wheel Size, in.	12½	16	20	25	32
Maximum hp	4000	5000	7000	10,000	16,000
Maximum rpm	16,000	12,500	10,000	8000	6000
Maximum P_1, psig	1500	1500	1500	1500	1500
Maximum T_1, °FIT	950	950	950	950	950
Maximum P_2, psig	300	300	300	300	50
Exhaust Size, in.	20	24	30	36	48
D. F. Exh. Size, in.	30	36	48	42 x 64½	48 x 84
Max. Inlet Size, in.	5	6	8	10	12

(For special applications, inlet steam conditions to 2400 psig, 1050° F total temperature can be accommodated.)

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Equipment . . .

action. No tools are required for these adjustments.

A minimum number of pivots are used throughout the indicating and control mechanism to assure accuracy and freedom from wear. All motion is transmitted through precision ball or needle-point bearings. Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

Circle E21 green card, last page

Valve Buyer's Guide Compares Manufacturers

In the interest of producing an all-inclusive information piece for valve specifiers, users, and purchasers, the company has designed a new "buyers guide" with valve comparisons.

In addition to cross indexing the complete line with the valves of sixteen major manufacturers, the "buyers guide" contains a list of frequently used abbreviations, a valve trim chart, a list of valves conforming to federal specifications, and complete figure number descriptions.

A breakdown of the product line by valve material and pressure class, and classification by type disc design, seating arrangement, stem operation, bonnet, and end connection serves as an additional guide to proper valve selection. The Ohio Injector Co.

Circle E22 green card, last page

Sorptometer Simplifies Surface Area Measurement

Simple and accurate studies of surface area and other adsorption phenomena have been made possible by the introduction of a unique new type of sorptometer. Manufactured under exclusive license from Shell Development Co., the Model 212 Sorptometer will find application in any field where examination of the physical properties of solids is required.

In operation the unit passes a known helium-nitrogen mixture through a sample cooled by liquid nitrogen. The change in the mixture's nitrogen concentration is measured by a thermal conductivity detector and inscribed as a peak on a potentiometer recorder chart. A second peak is then obtained by warming the sample and measuring the amount of nitrogen released. The two peaks' areas are proportional to nitrogen adsorbed and desorbed. A simple calculation then affords the required data.

Applications of the Model 212 will cover a broad range of quality control and development areas. Refineries will also find it of considerable value in routine analyses of uniform samples such as silica-alumina cracking catalysts. Perkin-Elmer Corp.

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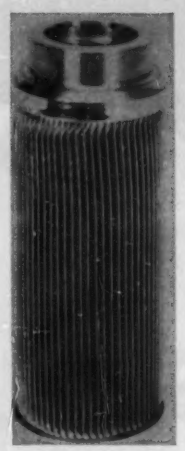
Wire Mesh Filter Parts Locked for Leak-Proof Seal



New lightweight filters free of built-in contamination, with media elements locked together mechanically by a specially-developed high pressure process, have just been announced.

The new process locks together all components of the filter element so securely that the filter medium is embedded in the parent metal of the end caps to form a leak-proof seal. Since the new process requires no welding, aluminum and dissimilar metals can be used in filter designs.

The new pressure-locked units are designed for all types of filtration including oil, fuel, or pneumatic systems and for any applications where wire mesh filter media of stainless steel, monel, or phosphorous bronze are required or desired. Purolator Products, Inc.

Circle E24 green card, last page

NEW . . .
from Manzel
FLOW-actuated alarm
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MANZEL
LUBE-LINE ALERT
LUBE-LINE ALERT gives positive protection to valuable compressors, engines, machinery and other equipment using force feed lubrication. Small, compact precision-made FLOW alarm inserts into oil lines near each terminal point.
• Fits any make of lubricator
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• Signals LACK OF FLOW through line
• Flow capacities from ½ cc to 2 qts/min.
• Handles any viscosity oil or synthetic
• Pressures to 10,000 psi in standard models
• Explosion-proof units available
FREE Specification Sheet gives complete details. Write for your copy.
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Box 2608, Houston 1, Texas

Check Petroleum Blend With This Small Computer

A small, transistorized, scientific computer which can perform more than 100,000 calculations a minute has been announced.

Requiring little more space than the average desk or drafting table, the new IBM 1620 Data Processing System operates under the direction of an internally stored program of instructions. It can perform complex engineering and scientific computations on a continuous or production basis. The 1620 is particularly adaptable to problems such as oil pipeline transmission and product inventory, and petroleum blend evaluation.

Advanced features incorporated in this compact but powerful computer include 20,000 digits of magnetic core storage with variable field length and immediate accessibility, and paper tape and electric typewriter input and output. The availability of two advanced programming systems and a comprehensive library of mathematical and statistical routines simplifies programming for the 1620. Specific programs for the petroleum industry will be available. The first systems are expected to be delivered late next year. The system will rent for $1,600 a month, and sell for $74,500. International Business Machines Corp.

Circle E25 green card, last page

Thermal Insulation Cement Re-Workable After Drying

A new product in the field of thermal insulation is a castable, quick-set, one-coat insulation cement. It is unique in the fact that it can be packed by hand, troweled, injected, palmed, sprayed or poured to any thickness without shrinkage.

A remarkable feature of this cement is re-use of the set or dried material.

This cement can withstand freezing with no deteriorating effects. It is non-rusting and non-corrosive to metal and materials, especially aluminum.

Premolded pipe fittings of any size can be made in two pieces and are easily applied. The price is low enough for practical use.

K factors are considered low enough to be more than satisfactory for any temperature range. Thermold Products Co.

Circle E26 green card, last page

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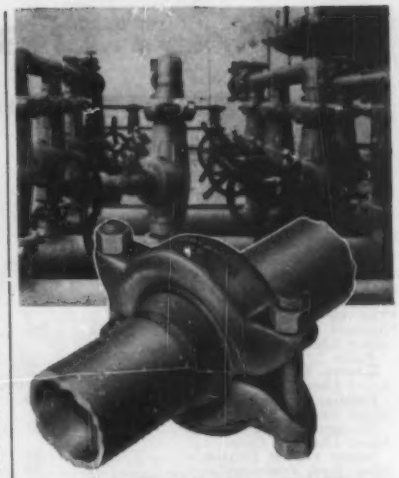

GRAYLOC® SAVES 3 WAYS FOR OEM

Original Equipment Manufacturers save on space, weight, and time when reliable GRAYLOC is specified for piping connections for their products.

The compactness gained with space-saving GRAYLOC might make your product adaptable to more applications. Example: Five Grayloc-equipped valves can be installed in the space normally used for four flange-type valves in a manifold hook-up.

Weight-saving GRAYLOC makes many units easier to handle, certainly it will save you freight costs since GRAYLOC weighs up to 90% less than comparable-sized flange connections. Yet there is no loss of strength. Example: 4-inch GRAYLOC with a rating of more than 6,000 psi weighs 35 pounds compared to the 450 pounds of a flange connection with a comparable rating.

GRAYLOC connections can be made up in as little as 3 minutes time by unskilled laborers and are positively leak-proof every time.

GRAYLOC connections have practical applications wherever flanges are used. For additional information concerning the savings you can have with GRAYLOC, contact Gray Tool Company.

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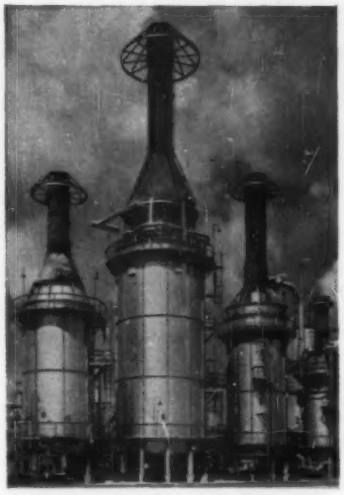

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NOOTER

FLOATING ROOF TANKS

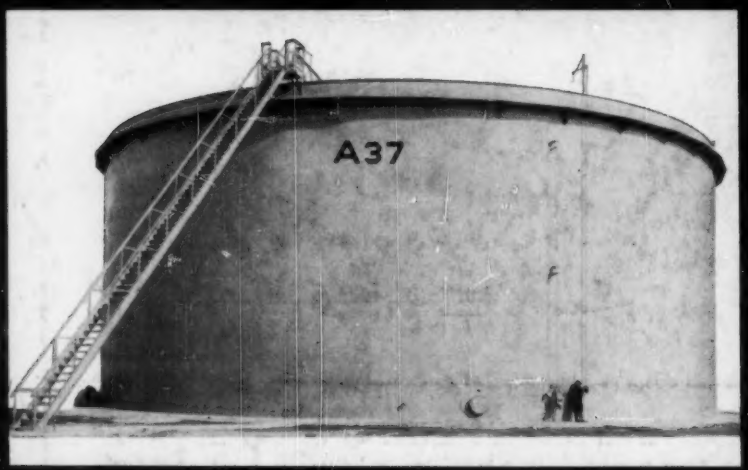
Offer the

MAXIMUM

SEAL PROTECTION

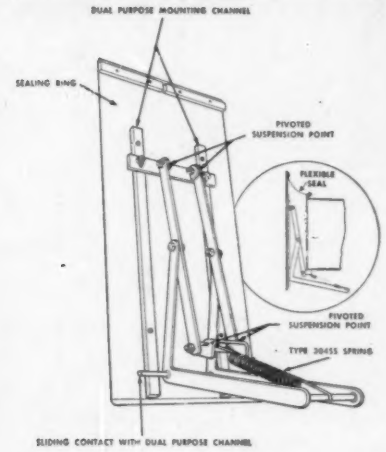
MINIMUM

MAINTENANCE

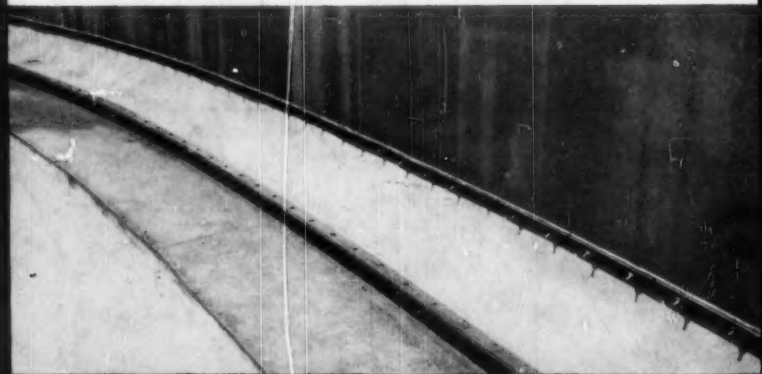


NOOTER is fully experienced in the fabrication and erection of double deck, pontoon and pan type floating roofs—all with the patented Nooter Seal. The Nooter design means better protection for your product because of the more efficient seal . . . minimum maintenance because there is no direct contact with the sealing ring, therefore minimum wear . . . and minimum delay in construction because easier installation and alignment are made possible by the new seal design. These advantages mean a better floating roof tank at a lower cost.

This Patented NOOTER SEAL HANGER is One Reason Why!



This exclusive Nooter 2-Point suspension seal hanger has one pivoted and one sliding point of contact with the dual-purpose mounting channel. This channel serves (1) as a means of attaching seal hanger to shoe without direct contact of seal hanger to shoe, and (2) as a method of providing even distribution of the forces of seal hanger over entire height of shoe.



you can also update your old tanks with the new NOOTER SEAL

The Nooter Seal is readily adaptable to any existing welded or riveted tank. Requires minimum modifications for fast, easy installation.

For your next floating roof tank, or seal replacement, send your inquiries to Nooter. You'll find Nooter quality and dependable deliveries your best equipment investment.

Catalog 158 on Nooter Floating Roof Tanks is yours for the asking.

NOOTER CORPORATION

"Since 1896"

Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

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